REFINER
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Editor

GEORGE REID
Associate Editor

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REFINER
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INASMUCH as progress in the refining art is contingent upon like progress in equipment design, and the ability of the individual in the industry to progress is largely influenced by his knowledge of both equipment and process development and improvement, this issue of THE REFINER AND NATURAL GASOLINE MANUFACTURER is devoted to equipment engineering advancement.

Because of the unusual differences in raw material (crude petroleum) the most difficult process industry which equipment manufacturers have to serve is that of petroleum refining. It is an old adage, and a practically true one, that "no two crudes are alike."

Chemical engineering, or more specifically petroleum chemical engineering, in the laboratories of the refining industry and the equipment manufacturer, in the past 15 years has completely eliminated former usage of "rule of thumb" practices in the oil refinery. The profession has supplemented, instead, a vastly important array of improved processes specifically adapted to almost individual, or at least regional needs of petroleum refineries. As a result of the rapid influx of new processes, the demands upon the chemical engineer are constantly increasing.

The decided trend toward operation at high temperatures and pressures, the ever increasing improvement in instruments designed for control of temperature and pressure operations, the important periodic offering of new construction materials, new methods of heating through improvement of furnaces and the utilization of such indirect heating mediums as mercury and diphenyl, the substitution of one type of equipment for another as that of tube stills for shell stills, the perfection of improved types of transportation equipment with improved motive power equipment, changes in crystallization and extraction practices with subsequent perfection of improved products—all these and more, force the industry and its supplying equipment manufacturers to be constantly alert and informed of such improvements in practice and equipment.

In this, the equipment engineering issue of THE REFINER AND NATURAL GASOLINE MANUFACTURER, there is presented a series of articles especially prepared for presentation at this time by many of the leading engineers of certain equipment manufacturers. Some of these discussions are elemental for the reason that it is felt there is a need for such information; others are for the most part presented as semi-technical discussions of various problems. The issue is devoted primarily to the application of technical equipment to both technical and practical operating problems as found in the manufacturing branch of the petroleum industry.

EQUIPMENT ENGINEERING PROGRESS REVIEW

Tube Stills

By JOHN C. GLENN
Foster Wheeler Corporation

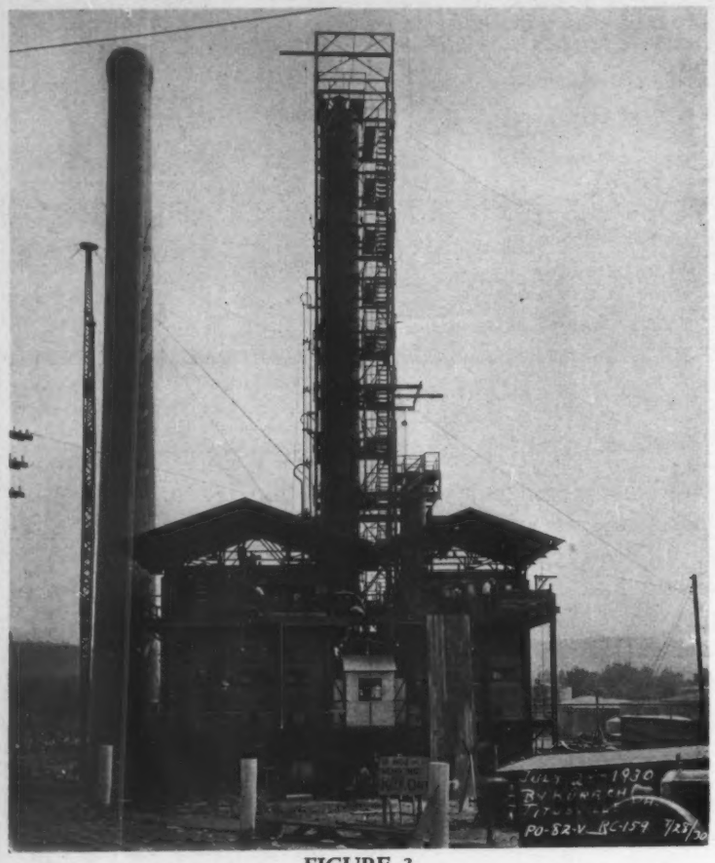


FIGURE 3
Two refinery units processing Pennsylvania crude. The tube still at the left, with its atmospheric tower in the background charges 3,000 barrels per day, recovering seven different fractions.

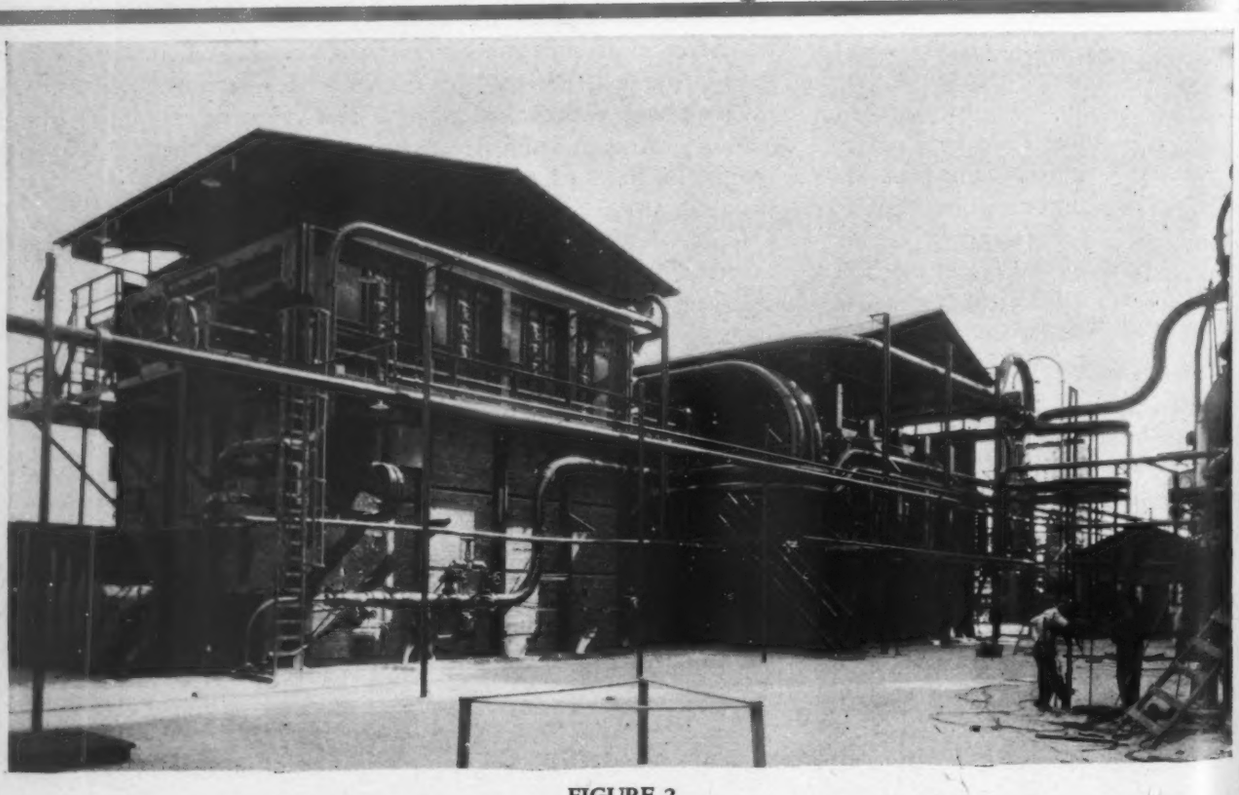


FIGURE 2
Two tube stills in vapor phase cracking work. The first one is used as a vaporizer and the second as a vapor superheater.

Their Uses in Modern Refineries

ALTHOUGH the tube still — to use the more popular name of what should correctly be called the tubular type oil heater—was used many years before it reached its modern form, it did not come into prominence until the heat absorbing surface was divided into radiant and convection sections.

In early stills, before a radiant heat absorbing section was installed, the maximum rate of transfer of 25,400 Btu. per square foot per hour was too high and 290 Btu. per square foot per hour obtained in the last row of tubes was too low. The average maximum in the modern still is only slightly more than one-third the rate in the old style stills and, due to the use of extended surface, the rate of absorption by the oil per square foot of wetted surface in the last row of tubes is correspondingly higher.

The adjustment of the heat transfer rates permits operation at higher temperature of the oil within the tubes and higher efficiency of combustion in the furnaces. The possibility of heating the oil to higher temperatures without overheating widened the scope of the tube still. The ability to operate with higher CO_2 or less excess air resulted in great increase in fuel efficiency and permits pulverized fuel firing of coal or petroleum coke with great economies in many plants.

The first tube still of this design was developed for the removal of free, fatty acids from vegetable oils; it was designed in 1920 and put into operation early in 1921. It was followed a few months later by a tube still for heating petroleum to 750° F. The separation of radiant and convection heat absorbing surfaces was accomplished by placing the convection absorbing surfaces behind a bridge wall and by placing the radiant heat absorbing surfaces in the roof removed from the path of gas flow. This construction was further modified by increasing the external heat absorbing surface of the convection tubes per lineal foot to compensate in part for the decrease in gas temperature as gas passed through the convection tube bank.

The modern tube still is designed to operate at efficiencies in excess of 80 per cent. Recirculation of flue gas and the operation with large quantities of excess air is not necessary with a properly designed furnace but the use of preheated air for combustion is employed extensively. The use of preheated air is made possible by increasing the amount of radiant heat absorbing surface to prevent a rise in furnace temperature. Air heaters are now part of the standard equipment supplied with modern tube stills charging oil at high temperatures.

Aside from the high efficiency of tube stills, the outstanding feature is their extreme flexibility, permitting their use in all types of oil refinery processes, involving the heating of crude oil or its fractions. By proper proportioning of radiant heat absorbing surface and convection heating surface, and regulating the velocities and temperatures, as well as pressure and time factor, the tube still may be used either for cracking or for vaporizing at high temperatures without cracking. The same design may also be used with high efficiency for vaporizing distillate from cracking stills at low temperatures to provide a stable product.

Cracking processes may be divided into two main

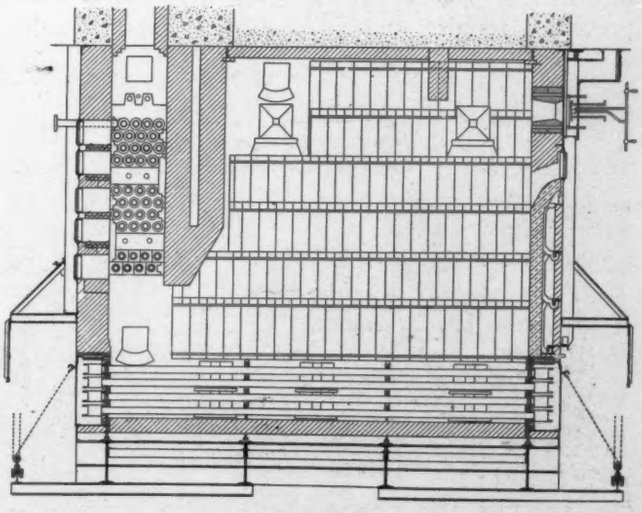


FIGURE 1

Diagram showing arrangement of heating surface in typical heater for liquid phase process.

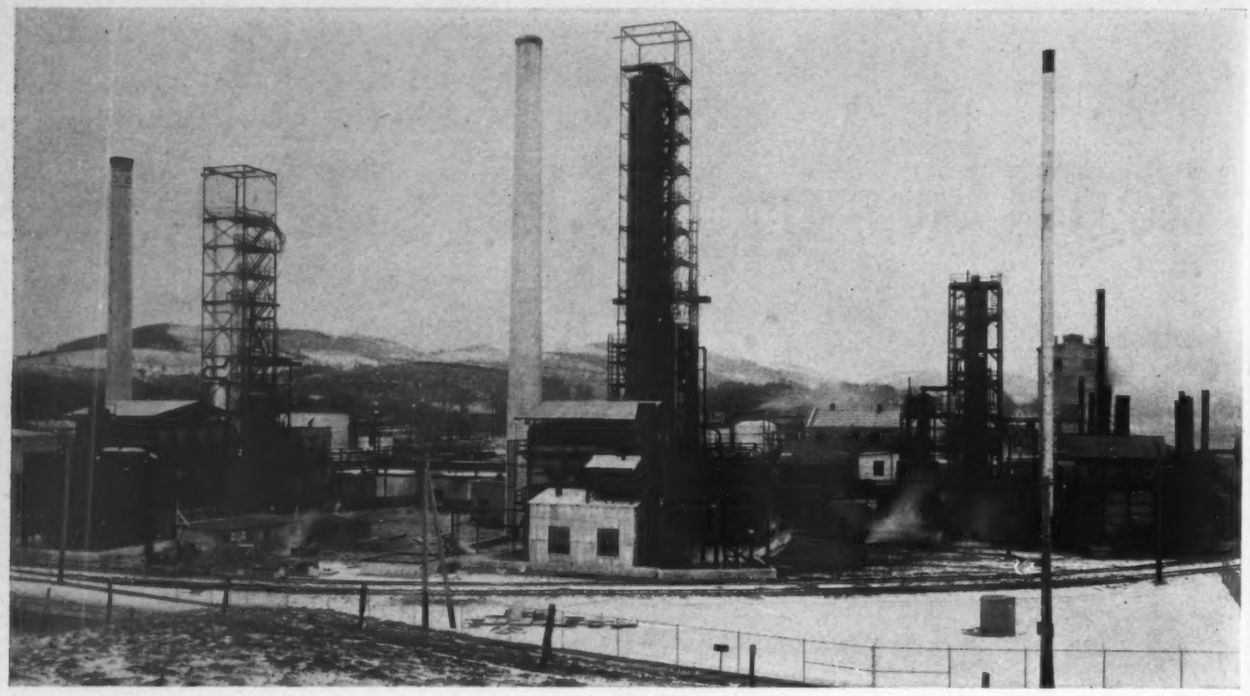


FIGURE 4

Refinery in the Pennsylvania oil fields showing three single flash distillation units. The unit at the right is the first single flash unit to obtain lubricating stocks from Pennsylvania crude in a single continuous operation. The unit in the center recovers 10 different fractions from 7,500 barrels of Pennsylvania crude. A drawing showing the tube still and pulverizer arrangement is shown in Figure 5.

classes: liquid and vapor phases. The vapor phase process is of increasing popularity, but is not in as wide use as liquid or semi-liquid phase at the present time. Tubular heaters supply the heat required in both cases. Heaters for liquid and semi-liquid phase processes are very similar in design; drawing of a typical heater for one widely used process is shown by figure No. 1. For best operation, both of these processes require tubular heaters, made up in the most modern units of two or four rows of roof tubes and 10 to 14 rows of convection tubes. In the larger units, side wall radiant heat absorbing tubes are also used to obtain the proper ratio of radiant to convection surface. To obtain higher efficiencies, heaters are equipped to preheat the air for combustion by recovering some of the heat in the flue gas.

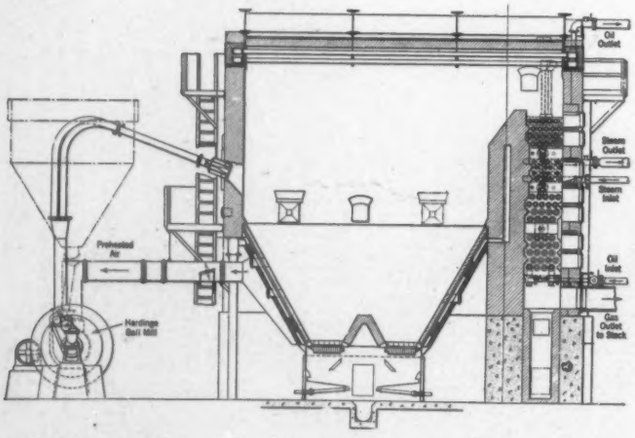


FIGURE 5

Diagram of the tubular oil heater which forms part of the 7,500 barrel distillation unit shown in Figure 4. The tube still is arranged for both pulverized fuel and oil firing. Preheated air for use in mill drying of fuel is obtained from the air cooled bridge wall and hopper bottom. The hopper bottom facilitates the removal of ash accumulated when pulverized fuel is fired.

Several years ago the heaters for cracking units were installed with a single row of tubes in the roof. Many of these heaters are being modernized by the addition of more roof tubes. The installation of a second row increases the Btu. absorption of the heater considerably. The addition of third and fourth rows of roof tubes does not affect the Btu. absorption materially, but increases the time element at the cracking temperature to such an extent that the yield of pressure distillate is increased. Test data from a heater recently changed from one to four rows of roof tubes shows that the thruput may be increased 50 per cent without encountering destructive furnace temperatures. The yield of pressure distillate has been increased 35 per cent by the additional time element imparted by the third and fourth rows. In addition to the increased yield, it has been possible to lower the oil temperature to 50° F.

Vapor phase cracking units are of more special and less standardized design. One outstanding unit of this type is shown by figure No. 2. The heating being done in two tube stills; the first is the vaporizer, and the second the vapor superheater. The

vaporizer, containing both radiant and convection surface is equipped for oil burning and gas and in addition to the separate firing, also receives the flue gases from the superheater. The superheater contains only radiant heat absorbing surface, the gases being discharged into furnace of the vaporizer.

TUBE STILLS AND FRACTIONATION

In recent years, the tube still has been installed principally in connection with single flash and two-stage units in connection with various types of fractionating columns.

One of the major advantages of tube stills for this type of service is the ease with which an integral superheater can be installed. The result is that practically every tube still in a complete distillation unit is equipped with a superheater to supply high temperature steam to the fractionating tower for process work. This steam is usually the exhaust from the pumps.

Complete distillation units composed of tube still and bubble tower, with auxiliary equipment have been installed in all parts of the world.

Atmospheric units may be used to obtain high grade lubricating stocks. Figure 3 shows a unit which charges Pennsylvania crude and recovers seven different fractions, as follows: gasoline, special naphtha to Stoddard solvent specifications, kerosene, gas oil, wax distillate, heavy wax distillate, and cylinder stock.

The tube still with its high efficiency and continuous operation, not only makes possible the use of large fractionating columns, but permits using the same unit for charging many different kinds of crude, due to its ability to vaporize all kinds of crude without overheating or cracking. The unit shown in figure 3 is arranged for charging Mid-Continent crude as well as Pennsylvania crude, recovering overhead cylinder stock and flux bottoms, instead of cylinder stock bottoms as is regularly done with Pennsylvania crude; the specifications of the other fractions remaining unchanged except for relative yields.

The first single flash distilling unit to fractionate Pennsylvania crude to cylinder stock bottoms is shown in figure 4. It is the unit at the extreme right with the steel stack. It is fired with pulverized fuel

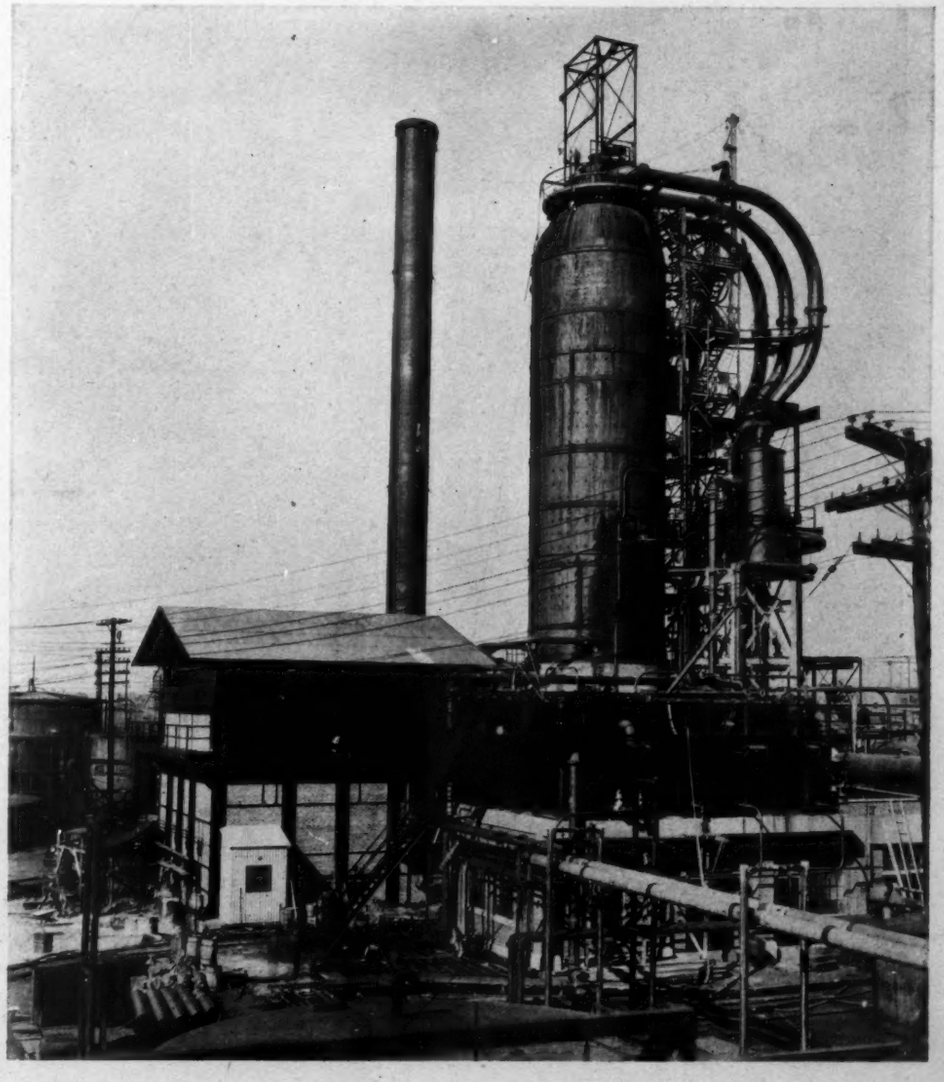


FIGURE 6

Vacuum single flash distillation unit showing the tube still at the left. This unit charges 9,500 barrels of reduced crude per day, recovering in addition to overhead vapors and bottoms, three liquid side streams of lubricating stocks.

or oil as are the other two units in the picture. The rate of charge is 3000 barrels per day. The large unit near the center of the picture recovers 10 fractions from a daily charge of 7500 barrels. The tube still arrangement and pulverized fuel firing equipment of this unit are shown by Figure 5.

In many of the older refineries such elaborate and extensive batteries of shell stills are in operation that the owners do not wish to scrap them. However, in many of these refineries, tube stills have been installed for distillation of reduced crude obtained from batteries of shell type topping stills. The largest unit of this kind in the world is located in an Eastern refinery and is shown in Figure 6. An original charge of 20,000 barrels of Mid-Continent crude per day is topped in shell still batteries, leaving a residue of 9500 barrels of reduced crude, which is heated in a single tube still and then discharged to a vacuum bubble tower. This permits utilizing existing equipment for recovery of the lighter products without excessive fuel waste, but enables the heating at higher temperatures in the more efficient tube still. Furthermore, the use of the vacuum tower reduces the percentage of bottoms and increases the yield of heavy lubricating stocks.

In many of the vacuum distillation units for reduced crude, air heaters are installed to increase the efficiency of tube still. The flue gas temperature leaving the tube still is governed by the temperature of the oil entering the still, generally being about 200 degrees higher in a well designed unit. In many of the reduced crude vacuum distillation units the charge enters the still at a high temperature from the shell still battery. This makes the temperature of the gases leaving the still excessive, and air heaters are resorted to for fuel saving. Figure 7 shows such a unit in an Eastern refinery, charges 7500 barrels per day of reduced crude received from batteries of shell stills.

For the complete distillation of large quantities in single units, the two stage unit is often adopted. In this type of installation two tube stills with their

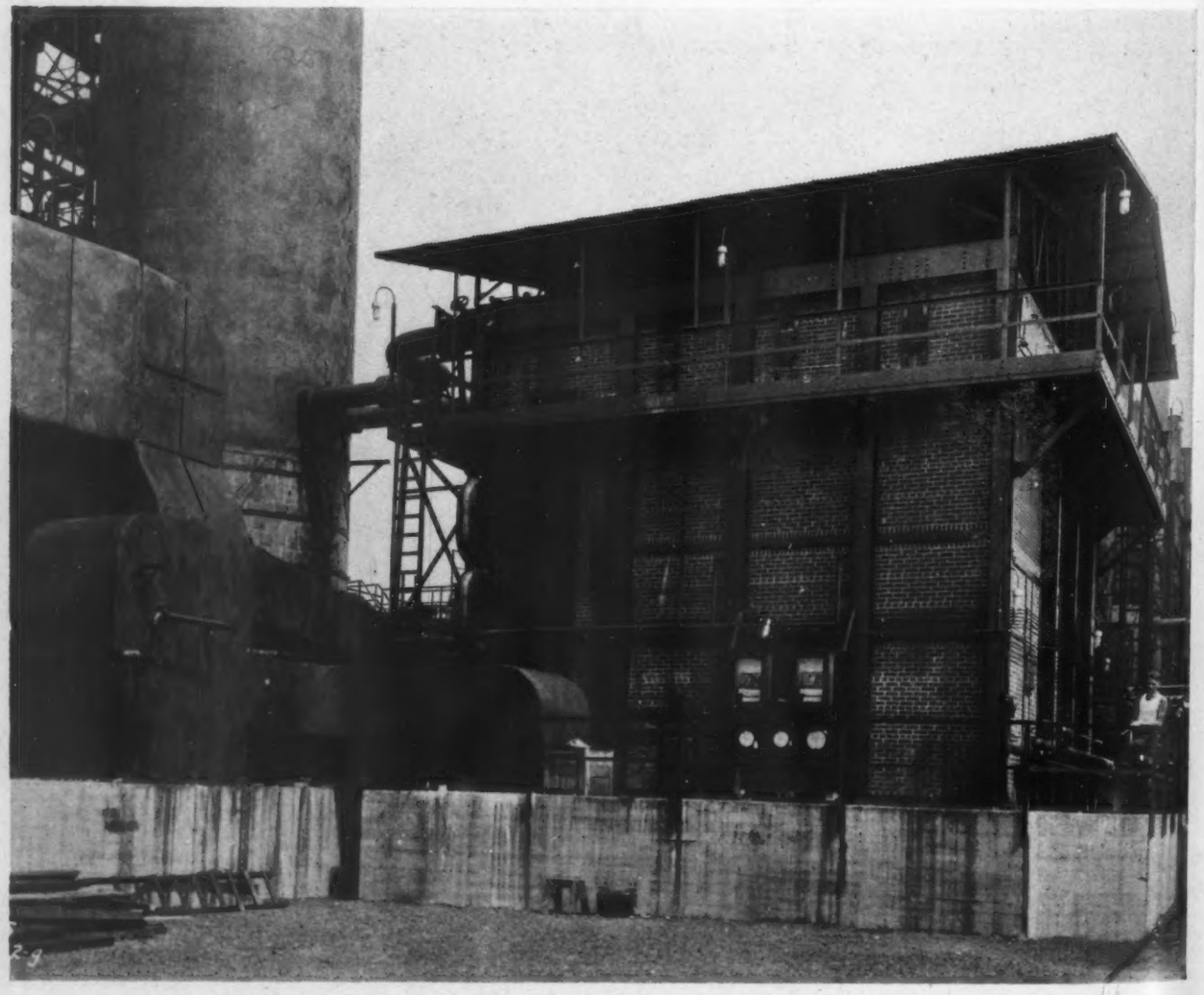


FIGURE 7

Tube still of vacuum distillation unit in an Eastern refinery. Heated oil flows from the tube still, flows into the vacuum tower, partially shown in the left background. The flue gases from the still pass through the plate type air heater shown in the left foreground.

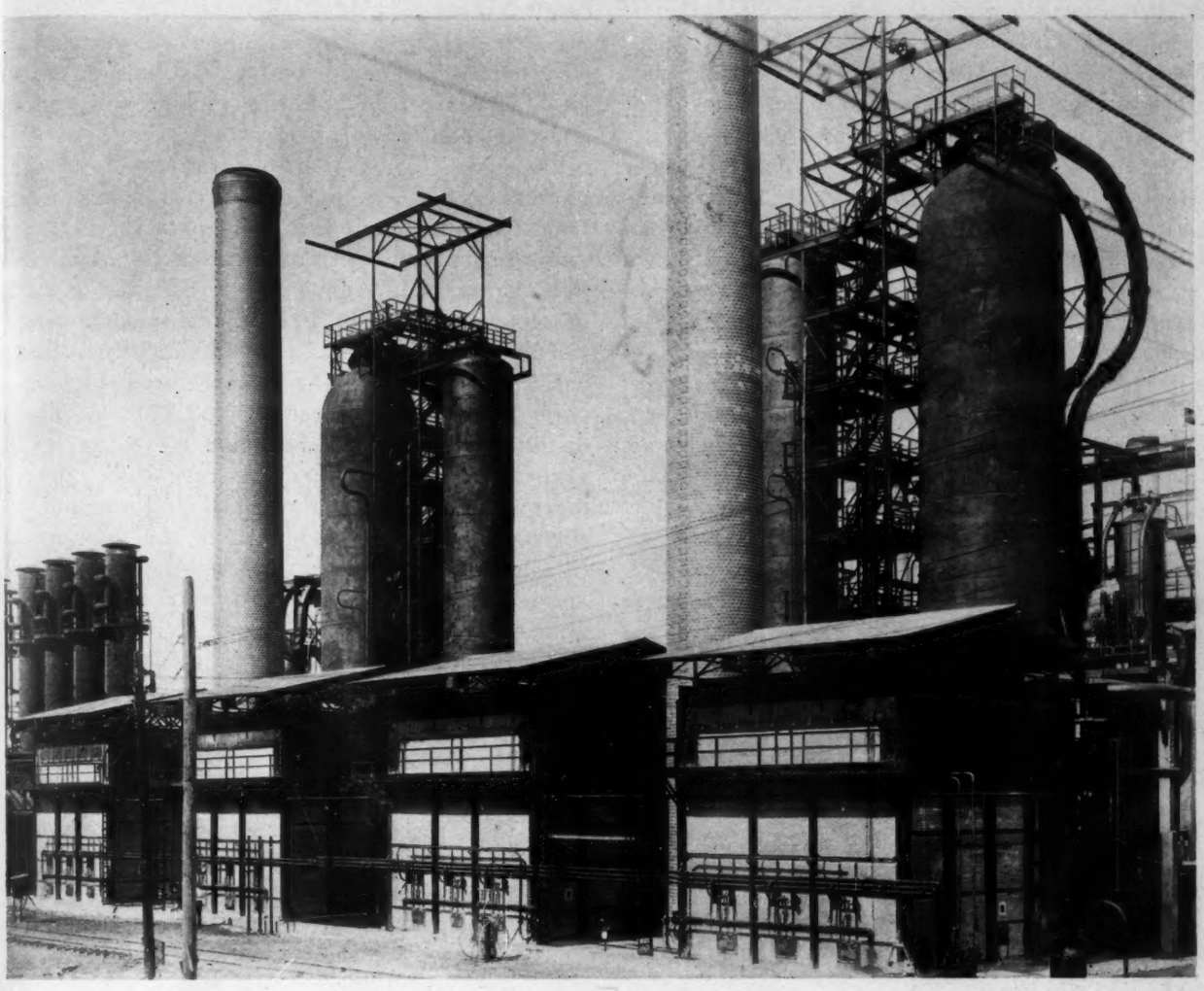


FIGURE 8

Two stage distillation units. Each unit charges 14,000 barrels of crude per day recovering gasoline, naphtha, kerosene, light gas oil, heavy gas oil, wax distillate, overhead cylinder stock, and flux bottoms. These units are placed on a rectangular plot of ground only 144 x 200 feet.

towers operate in series. The first tube still receives the entire charge from heat exchangers and heats the charge sufficiently to vaporize about half of it. The oil is then discharged to an atmospheric bubble tower or fractionating tower, where the lighter fractions are removed. The residue is pumped to a second tube still where practically all of it is vaporized before being discharged to the flash chamber of the vacuum tower. The first two-stage unit was installed in a locality which has an established reputation for long periods of disagreeable weather and long hard winters. The two tube stills and the platforms between the towers were completely enclosed to afford protection to the operators. The unit was designed for the continuous recovery of eight fractions from 6000 barrels per day of Pennsylvania crude. It is operated, however, recovering products of the same specification from charges up to 8000 barrels per day.

In the two-stage units each heater is generally equipped with its own superheater. Units of this type have grown in both importance and size. They have been made in units up to 14,000 barrels per day capacity. Two of these units, which are reported to be the largest in the world, have been installed in a single refinery, shown in Figure 8.

The largest single battery, however, of two-stage units, or for that matter, units of any kind for the recovery of high grade lubricating stocks is at a Southern refinery which has installed a battery of four 10,000-barrel units in addition to another 10,000-barrel unit of this same type in a different part of the refinery. These four 10,000-barrel units are shown in Figure 9.

RERUNNING TREATED FRACTIONS

The tube still has achieved popularity in the re-running of various treated fractions. The re-running unit is made large enough to handle in a short time many days accumulation of any treated fraction or other re-run charge. The various re-running charges are accumulated, and when enough of any one is on

hand, it is run through in a continuous stream, until the supply of that charge is exhausted.

Figure 3 showing the atmospheric crude unit charging Pennsylvania crude, also shows at the right of the large unit, a small re-run unit which charges at different times, pressed wax distillate, cylinder stock solution and filter wash. These re-run units are usually built for atmospheric operation, but have also been built for vacuum operation. The one shown in Figure 3 operates at atmospheric pressure and has a capacity of 2400 barrels per day. A large re-run unit for lubricating stocks is the unit in the left of Figure 4, which charges 8000 barrels per day of pressed wax distillate.

Other refinery operations involving tube stills which may be classed as re-run operations are the making of high penetration asphalt and the contact treatment of lubricating oils with clay. A large percentage of high penetration asphalt is made by redistillation of flux bottoms and pitch, although there are several single flash and two-stage crude units producing asphalt.

The latest use of tube stills to be developed is the two-stage low temperature distillation unit for re-running treated distillate from cracking stills to obtain a product of stabilized color and high anti-knock qualities. Three of these units of one type are already in operation in different refineries, one charging 4000 barrels per day, the other two each charging 8000 barrels per day. Pressure distillate or cracked gasoline as received from the cracking still, contains many unsaturated hydrocarbons. Some of these cause poor color stability, disagreeable odor and gumminess. Others give it high anti-knock qualities for use as automobile fuel. Color stability, odor and gum are made to meet requirements of retail trade by acid treatment followed by redistillation of the gasoline at a very low and uniform temperature.

Tube stills have been designed which re-distill this anti-knock gasoline at a temperature which in no point of the cycle exceeds 250 to 275° F. The redistillation is accomplished in a two-stage distillation unit often including two tube stills operating in conjunction with atmospheric and vacuum fractionating towers. In some units the pressure distillate is delivered to the roof tubes of the first still and heated to 275° F. before being discharged to the atmospheric tower. The bottoms from the atmospheric tower are circulated through the convection tubes of the first still where they are re-heated to 275° F. Part is returned to the atmospheric tower and the balance is delivered to the vacuum tower. The bottoms from the vacuum tower are re-heated in the second still.

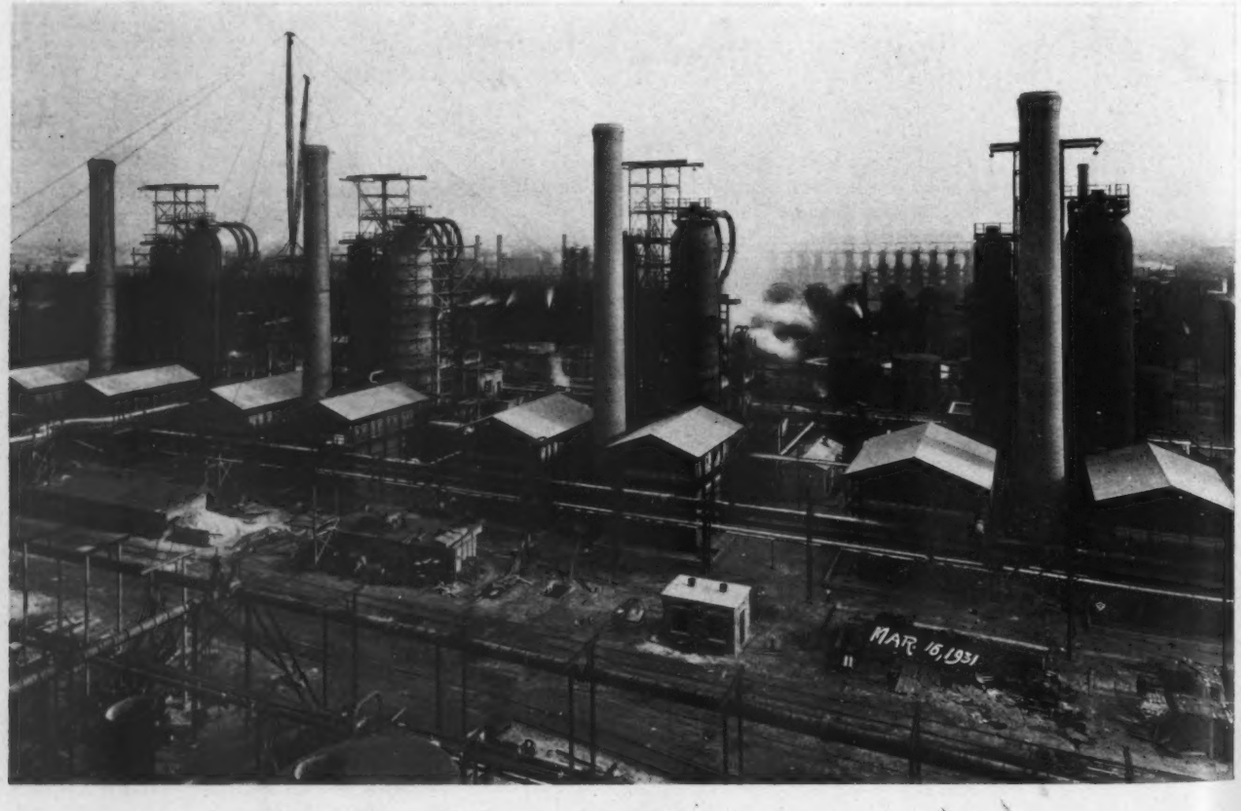


FIGURE 9

Large battery of distillation units producing high grade lubricating stocks. These four distillation units each have a capacity of 10,000 barrels of crude per day.

Burners for Firing Waste Fuels

By R. C. VROOM
Chief Engineer, Peabody Engineering Company

IN certain industrial processes and in particular in oil refineries there are obtained various combustible by-products or residues which can be used as fuel if suitable combustion equipment is employed. In the past, this utilization has been confined largely to those plants in which such materials were produced. In some cases their combustion has proven so difficult that it has been impracticable to consume them in such a manner. As a result they sometimes have collected in considerable quantities and their disposal has represented a serious problem.

In oil refineries, the use of such fuels has been coupled with the necessity for a great increase in heat liberation per furnace, per unit of furnace volume, and per burner, due to the fact that these fuels often must be used for firing larger units requiring a higher rate of heat absorption per unit of heating surface. Also, modern refining processes are sensitive to furnace conditions and necessitate a greater use of radiant heat transfer with a minimum of excess air.

The use of a few flexible and economical high capacity burners for fuel firing, in contrast to a great number of smaller units, is in accordance with the modern trend of design for fuel firing and other plant equipment. Burners are available in sizes to liberate up to 100,000,000 B.t.u. per hour when burning practically any liquid, gaseous or pulverized residual fuel, without any sacrifice in economy or flexibility, and with the ability to give absolute control over the furnace conditions.

PREHEATED AIR

Often such burners are used with highly preheated air. In oil still installations where there have been great advances in the methods employed, the use of preheated air has been developed beyond the range ordinarily found in power plants, temperatures approaching 1000°F. sometimes being employed. Such temperatures require the use of insulated panel burner register fronts and special metals, not only for the register parts, but for air preheaters and other equipment in contact with unusually hot gases.

The higher air temperatures increase the forced draft pressure necessary at any given fuel rate per burner, and the most careful burner design is required, while the use of highly preheated air speeds combustion. Air pressures must be maintained within reason and the cor- which the burner had when operating at lower temperatures must not be sacrificed. Maximum turbulence is essential, as each particle of fuel must come in intimate contact with the greater volume occupied by the air necessary to burn it.

It is necessary to have individual burners which are capable of handling standard as well as waste fuels at high capacity, and flexible combined units for two or three fuels, these being capable of obtaining maximum capacity with any one of the fuels. Plate 1 shows part

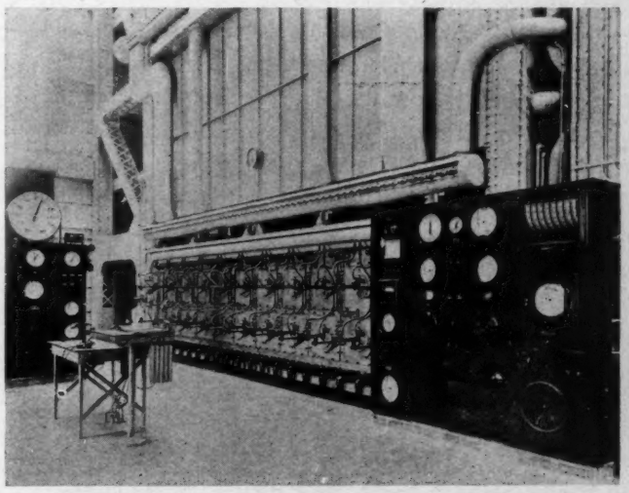


PLATE 1

of a boiler room having six 3400 horsepower boilers, each equipped with 20 combined gas and oi[1] burners similar to the design shown in Plate 4.

Until a few years ago, combined burners generally meant a multiplicity of burners for liquid, gaseous or pulverized fuels "combined" in the same furnace. What is meant in this paper by a "combined burner" is a burner in which any one of three forms of fuel, liquid, gaseous or pulverized, may be fired through the same

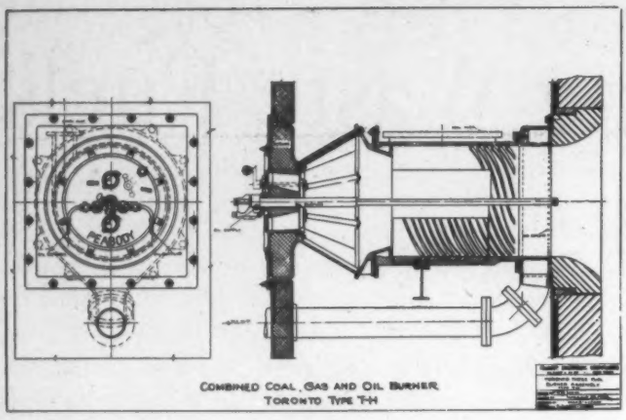


PLATE 2

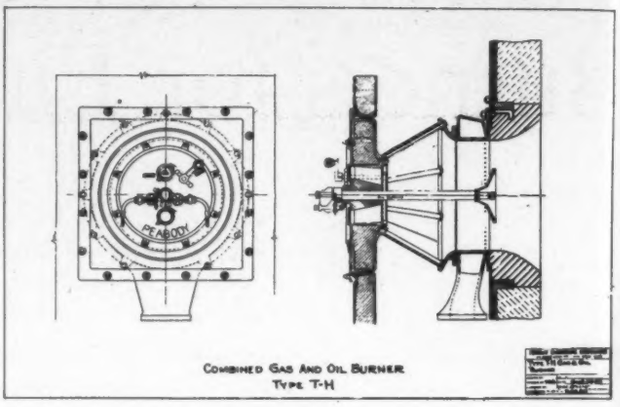
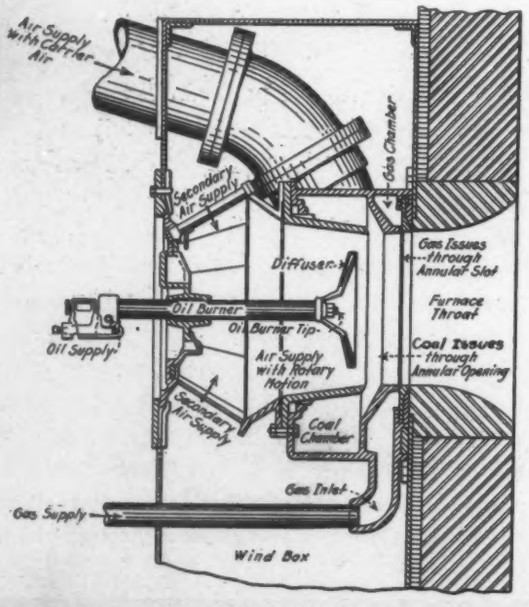


PLATE 4

throat opening into the furnace, and in which use is made of a common passage for the combustion air.

The advantages of combined burners are: The ease of operation due to a fewer number of burners. The simplicity of furnace and air duct construction and air control, due to the location of all burners in a single group in a common windbox, so that all fuels are fired through one furnace wall and with one set of throat openings into the furnace. The latter is of particular importance when water walls are used. The ability to keep in operation at all times all of the burners firing any one furnace, thus eliminating the necessity for protecting the burners not in service. The ability to light one fuel quickly from the other, permitting a practically instantaneous change in fuel without loss of output from the unit being fired. The ability to burn pulverized fuels of very low volatile content or fuel containing considerable water, as ignition can be maintained, when not otherwise possible, by also burning simultaneously a small quantity of another fuel such as oil or gas.



THREEFOLD BURNER—OIL, GAS, AND PULVERIZED COAL

PLATE 3

Plate 2 shows a convenient and reliable form of high capacity combined burner for firing three fuels. It is not necessary to remove a part of the burner for firing one fuel in order to insert a part of the burner for firing another fuel. The combustion air for the fuel being fired sweeps over and cools those parts of the burner for firing the other two fuels. A changeover can be made almost instantaneously.

The word "combined" as used in this connection must be taken in its proper sense, or else the full advantage of a combined burner will not be indicated. Until a few years ago, combined burners generally meant a multiplicity of burners for liquid, gaseous or pulverized fuels "combined" in the same furnace. What is meant in this paper by a "combined burner" is a burner in which any one of three forms of fuel, liquid, gaseous or pulverized, may be fired through the same throat opening into the furnace, and in which use is made of a common passage for the combustion air.

Combined units are advantageous for various reasons. In certain plants they are needed due to the fact that prices of the different types of standard fuels may fluctuate widely from time to time, and the use of such equipment enables the plant to burn that fuel which is the most economical. In some industries there are obtained from the various processes numerous waste fuels which are of such character as to have practically no market value, but the supply of such fuels is irregular or inadequate to carry the entire plant load continuously, with the result that provision also must be made for burning standard fuels.

Plate 3 shows a similar combined burner for lower capacities.

TYPES OF FUELS

In addition to natural gas, many kinds of industrial gases are being fired by such units, among these being refinery still gases. Such gaseous fuels sometimes have

(*Continued on page* 154)

Alloy Steels in Cracking Equipment

By GUSTAV EGLOFF and JACQUE C. MORRELL
Research Laboratories, Universal Oil Products Company

SPECIAL alloy steels of various compositions have been developed which are almost wholly impervious to the attack of corrosive agents under the temperature and pressure conditions which are found in the refining and cracking of petroleum.

Chromium and nickel steels are the alloys used in greatest proportion, but others are important, too, notably those with the addition of copper and silicon.

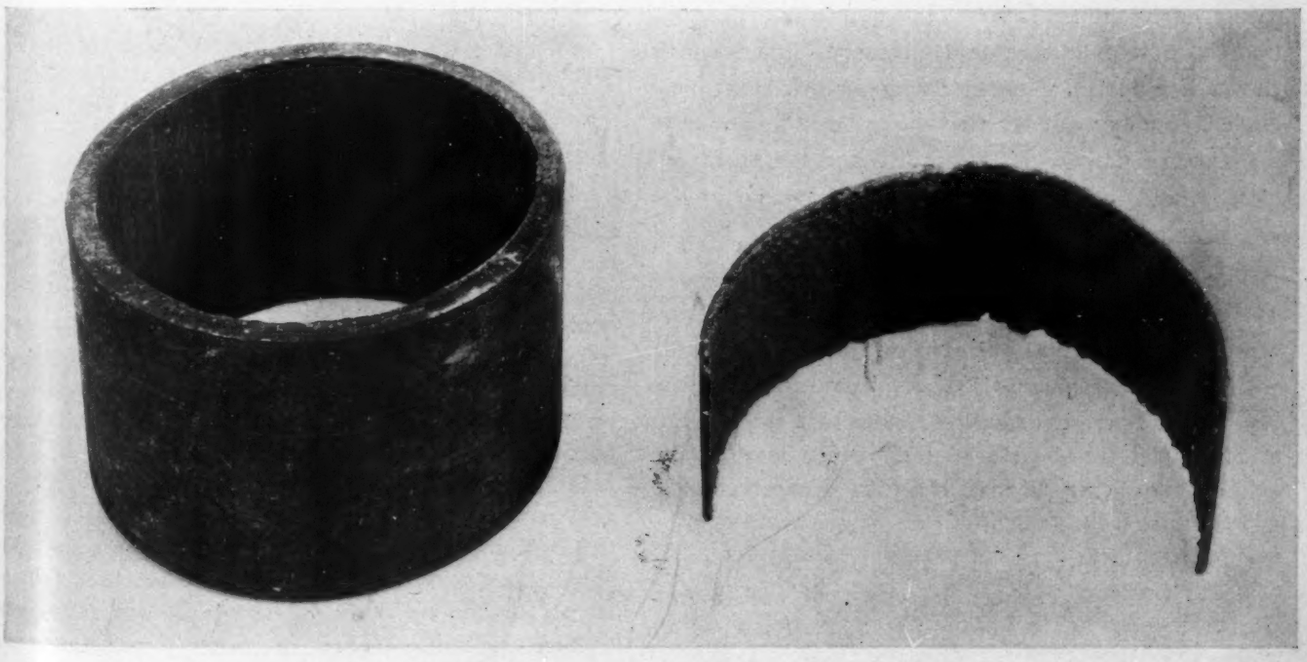
The refiner or equipment manufacturer who is called upon to select construction materials for use in refinery units must weigh the longer life of the alloys in service against their higher cost. The first consideration in such a comparative study is the loss of life which may result from failure of equipment; second, the loss of profit occasioned by frequent shutdowns for replacement; and probably last, the cost of the destroyed equipment itself, or property damage.

One large company cracking highly corrosive oils uses alloy steels in every practicable part of their installation.

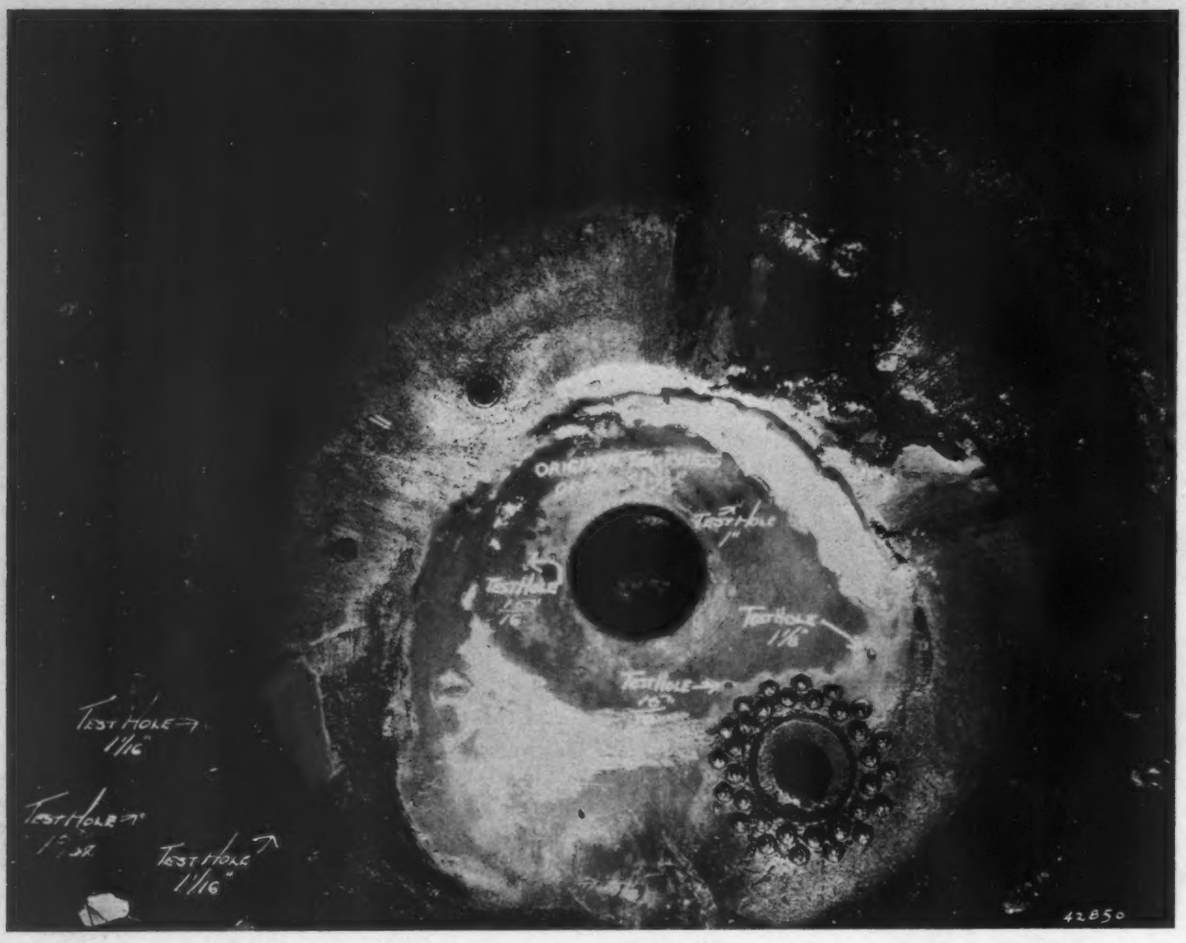
Other refiners believe that the high cost of alloys is not warranted since extra heavy steel parts of cracking equipment can be provided. They follow such installations with close inspection of the equipment for corroded parts.

Probably no general rule can be laid down as to the relative economic value of the expensive alloys and the cheaper steels. Each plant has its own conditions, usually different from those of any other.

Among the most important parts of the high pressure-high temperature equipment used in cracking are the furnace tubes. The tubes themselves are subject, not only to over-heating and strain, but to direct corrosive action from the oil passing through them. In the usual refinery, seamless steel tubing is ordinarily used, tubes with ¼ inch walls for most of the heating element and ⅜ inch walls for the top



Original and after removal, showing corrosion.



Corrosion—Reaction Chamber Head

rows. The life of those tubes, measured either in firing days or in barrels of oil thruput, depends upon the temperature and pressure under which they are used and upon the type of stock being processed. In many cases they have been found quite satisfactory with regard to safety and length of operation, and their initial cost is far below any more resistant type of tube.

The standard seamless cold-drawn steel tubes of ¼ inch wall have been used at high pressure and temperature on Mid-Continent oil for 506 firing days with a total throughput of 515,275 barrels of oil before replacement was necessary. Under higher pressure, similar steel tubes with ⅜ inch walls have shown a life of 490 firing days with a total thruput of 598,687 barrels.

Calorized steel tubes, i. e., tubes of steel, the surfaces of which have been impregnated with aluminum at 1750°F., have been used. Some comparative data on ¼ inch wall, plain seamless-steel tubes, ⅜ inch wall plain seamless tubes, and calorized ⅜ inch wall steel tubes in the top row of the same cracking equipment present an interesting picture in the following table:

Unit No.	Kind of Tube	Firing Days	Bbls. Thruput
2	⅜" Plain	53	31,324
2	⅜" Single Calor.	74	45,342
2	¼" Plain	21	12,044
6	⅜" Plain	171	193,120
5	⅜" Single Calor.	167	171,130
5 & 6	¼" Plain	144	20,785
9 & 11 incl.	⅜" Plain	236	290,786
13 & 16 incl.	⅜" Plain	239	256,119
12	⅜" Calor.	307	349,453
12	1.4" Plain	24	63,536

Failure of the plain cold-drawn steel tubes or of the calorized tubes is not necessarily caused by corrosion. In the case of the ordinary steel tubes, overheating and oxidation have been known to be causes for failure. Calorized tubes which have shown neither corrosion nor oxidation have been known to be affected by overheating to the extent that their tensile strength was reduced and the tubes bulged, making removal necessary.

Where highly corrosive stocks are charged through the equipment, trouble arises, and improvements or substitutes must be sought. Chromium steels have been found to be the most successful for resistance to corrosion. The degree of corrosion resistance increases, in these alloys, with increase in chromium content, but other properties, such as strength and ductility, vary according to the different proportions of the components. The optimum composition of the material can only be determined by taking into

consideration the conditions of the individual case. When the ordinary tube is unsatisfactory, but where conditions are not excessively severe, oil refiners are using a 4-6 per cent chromium seamless steel tube. These tubes cost approximately three times as much as ordinary steel tubes.

In many cases, however, equipment is subjected to extreme conditions of oxidation and corrosion, and lives as well as profits are endangered when material used in the equipment may not "stand-up." Steels of higher chromium content have been developed for this purpose, and these alloys usually contain nickel or some other suitable metal. One of the most successful steels developed is the 18 per cent chromium-8 per cent nickel-steel which has been the subject of much experimentation. Results show this material to be highly resistant to all conditions met with in modern cracking equipment. Tubes of this material, however, are priced ten times more than ordinary steel tubes. Such a wide difference in cost is not always warranted, unless the danger to life and the frequent shut-downs for repairs and replacements are sufficiently great.

Where the need for protection overbalances the high cost factor this 18 per cent chromium-eight per cent nickel material has shown interesting results. In fact, a tube made of this material has been reported to have processed more than 1,222,464 barrels of oil, as against a normal life for a steel tube of about 500,000 barrels.

Tubes made of the 18 per cent chromium-eight per cent nickel material are not only resistant to temperatures up to as high as 1300°F., but they are not necessarily permanently injured above that point. Some interesting information on the structure of this material may be quoted from one experimenter who says:

"In the event that 18 per cent chromium-eight per cent nickel cracking coil tubes are heated in service temporarily beyond the recommended 1300°F. maximum, no permanent injury will result to the metal and no annealing treatment is needed, provided the time period, or temperature is not sufficient to cause either carburization of the tube or incipient fissures from creep. Each case is an individual one and it is not possible to tell accurately whether the tubes have suffered unless they are cut and examined. In such cases, where failure has not resulted from overheating, no substantial harm is done and the tubes are safe for continued service at lower temperatures.

"Annealing by heating rapidly to the neighborhood of 2000°F., followed by quenching in water, will not restore material which is permanently damaged as enumerated above, i. e., by carburization, or fissuring due to creep. Other microscopic changes in structure are not of importance."

Materials for tube supports in high temperature-pressure cracking equipment are also subject to conditions of corrosion. In many cases cast iron tube supports have given satisfactory service. In various refineries, alloys containing small percentages of nickel chromium and aluminum have been used to advantage. Still other refiners have found heat-resisting castings containing 28 per cent chromium and eight per cent nickel are necessary for satisfactory results.

HEADERS AND PLUGS

A wide variety of materials have been used for return bend headers and plugs. Ordinary steel fittings have proved hardly satisfactory, especially where screw joints are used. With ground joints, corrosion of threaded parts is eliminated and the life of steel parts is considerably extended, although corrosion and still take a heavy toll. Parts constructed from an aluminum bronze alloy are somewhat superior to the ordinary steel fittings. This material, however, is not sufficiently resistant to high corrosion, to solve the problem of safety and long-lived equipment with certainty. The life of plugs made of this material ranged from one to 12 months, whereas ordinary steel plugs gave assurance of an average of 4½ to five months, or about 120,000 barrels throughput.

Plugs of nickel-chromium-iron, and chromium plated ones showed approximately the same effective life in similar equipment. Forged chrome-iron far surpassed either of these as a safe, strong material and cast chromium iron showed even longer life without sign of corrosion or other failure. A comparison in time of use of various types of return fitting plugs may be tabulated as follows:

Material of plugs	Life before replacement
Chrome plated iron	Four months
Steel	4½ to five months
Nickel chrome iron	Five months
Aluminum bronze	1 to 12 months
Forged chrome iron	Over eight months
Cast chrome iron	Over 17 months
Forged steel	Two years

Forged steel fittings, although their cost is higher, often warrant their extra cost since they have been found in good condition after as much as 925,000 barrels throughput. The ordinary steel header, like the ordinary steel tube, averages about 500,000 barrels throughput before requiring replacement.

Other materials have been used for fittings, however, including an alloy forged into plugs (threaded) which contains eight per cent chromium, 22 per cent nickel, 1.75 per cent silicon, one per cent copper and small amounts of carbon and manganese. Cast steel, too, containing 0.75 per cent chromium and two per cent nickel has been used successfully for return bend headers.

PIPING

Pipe connections on the reaction chamber, including the transfer line, vapor line, relief line, liquid level lines, residuum lines and top manway—as well as dephlegmator liners—probably follow the cracking tubes in amount of exposure to direct corrosion by the hydrocarbons going through the equipment. Here again, chromium steel has proven best to re-

sist the conditions existing in severe cases, although the amount of protection needed depends entirely upon the particular conditions in the equipment under consideration.

The pumps used in a cracking plant are also subject to conditions of temperature and pressure where corrosion may be active and often demand special construction materials. Liquid end and surge blocks in hot oil pumps are more resistant to corrosion when made of steel which contains 0.4 to 0.5 per cent nickel, than with ordinary steel. The valves, bolts and nuts of a hot oil pump, however, under severe conditions require the use of chromium steel containing from 12 to 18 per cent chromium. Hot residuum and hot feed pumps present much the same problem. These pumps offer another application for the dependable properties of 18 per cent chromium-eight per cent nickel steel, especially for the liquid end piston rods.

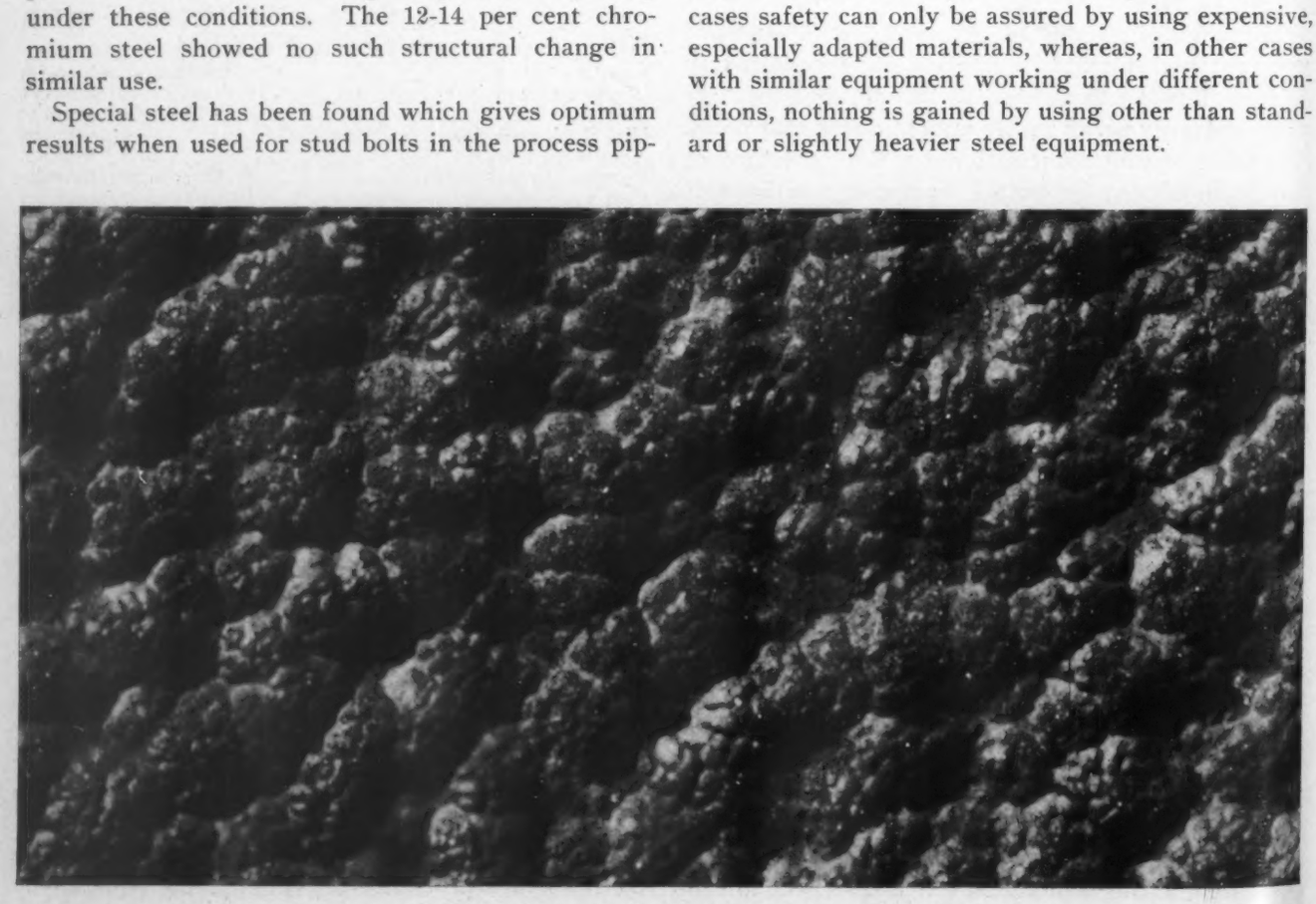
While miscellaneous cast steel fittings and valve bodies for cracking equipment working under 900 and 1350 pounds pressure are improved to reasonable safety even under severe conditions with the use of steel containing 0.75 per cent chromium and two per cent nickel, the trimming for such valves often requires an alloy containing more cromium. Tests on various compositions of steel alloys for this purpose indicated that material containing less than 12 to 14 per cent chromium showed grain growth or gauling under these conditions. The 12-14 per cent chromium steel showed no such structural change in similar use.

Special steel has been found which gives optimum results when used for stud bolts in the process piping of a cracking plant. Composition for such bolts includes very small amounts of sulfur and phosphorus in a steel which contains 0.4 per cent carbon, 0.8 per cent manganese, 0.7 per cent chromium and 1.5 per cent nickel.

Gaskets for high pressure service offer another point where the 18 per cent chromium-eight per cent nickel alloy is quite useful.

Besides the most frequently mentioned alloys in this discussion, which include the 12-14 per cent chromium alloy and the 18 per cent chromium-eight per cent nickel steel as well as the 7-8 per cent chromium-22 per cent nickel alloy which contains small amounts of copper and silicon, other corrosion resistant alloys are available for application where they are peculiarly adaptable. One of such materials is a steel containing small amounts of phosphorus and sulfur and 0.8 to 1.1 per cent tungsten along with 4 to 6 per cent chromium, 0.4 to 6 per cent manganese, 0.4 per cent silicon and 0.1-0.28 per cent carbon. This material has proven quite useful for valves in high pressure oil lines under certain conditions.

It cannot be too frequently emphasized that the use of any of these materials, whether alloys of iron or steel with aluminum, chromium, nickel or other corrosion resistant metals, or simply extra heavy forged or cast steels, depends entirely upon the particular conditions in the individual plant. In some cases safety can only be assured by using expensive, especially adapted materials, whereas, in other cases with similar equipment working under different conditions, nothing is gained by using other than standard or slightly heavier steel equipment.



Corrosion—Interior of Vapor Line

Developments in Synchronous Motors

By C. E. SWANSON
Engineer, Electric Machinery Manufacturing Company

SYNCHRONOUS motors have during the last decade become increasingly popular as an industrial drive. They now comprise about 20 per cent of the total motor horsepower installed in the United States.

Advantages which are inherent in the synchronous motor and which have proven a large factor in their acceptance as an industrial drive are: high power conversion efficiency with resulting lower operating expense, constant speed operation, operation at unity or at leading power factor, ability to be direct connected to the load, and simplicity of construction. The ability to be direct connected to the load has in many cases alone warranted the installation of a synchronous motor as it has meant reduction in floor space requirements and in maintenance expense, and the elimination of speed reducing devices.

The early synchronous motor was the outcome of the discovery of the reversability of alternators. It was found that if the driving arrangement of an alternator connected to a power system were removed, the alternator would take power from the line and run in synchronism with the power source. It further had the ability to carry a considerable load before being pulled out of step. Such alternators were the first synchronous motors, but because of their very low starting and pull-in torques their applications were extremely limited. It was generally necessary to have an auxiliary motor to start and bring the synchronous motor up to speed before it could be loaded.

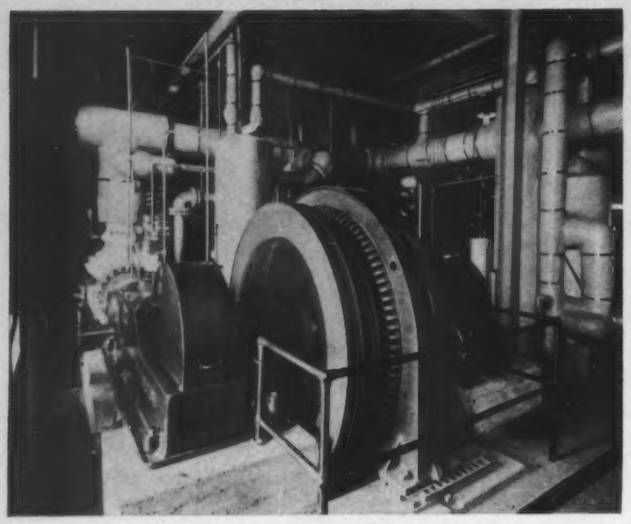
From this beginning, the synchronous motor has been developed, through years of constant experimenting and research to the position it holds today. Today the synchronous motor is recognized as the proper drive for a large number of constant speed applications covering practically every industry and ranging in horsepower from 20 horsepower upward, and for speeds of 72 up to 1800 revolutions per minute. Today the starting torque requirements of a drive are no drawback, for synchronous motors can meet the severe duty requirements of all the constant speed industrial drives.

An adaptation of the automatic control for induction motors was first used for synchronous motor control. In starting induction motors the transfer from reduced voltage to full voltage was made at any speed between 40 and 80 per cent of full speed and not at a definite speed which is required for satisfactory synchronous motor control. It was early realized that proper automatic control for synchronous motors would eliminate a big objection to their more widespread use, and that the correct synchronous motor control must be based on motor speed during the starting period.

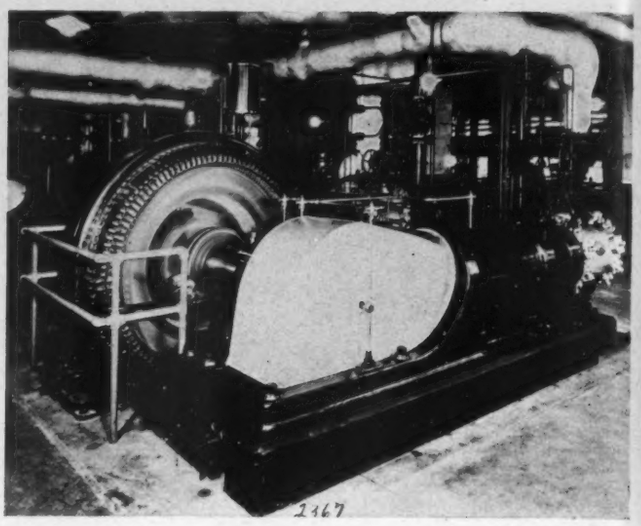
Engineers in 1917 originated the frequency responsive principle of control. The operation of this control was based on induced current in the field circuit. The frequency of the current induced in the rotor of the synchronous motor varies directly as the motor slip, or inversely as the motor speed. This accurate measure of motor speed is utilized to operate the control steps.

In the full voltage automatic starter, one frequency relay is needed to apply excitation to the motor field, and this is usually set to operate between 93 and 96 per cent of synchronous speed, according to the application. The relay actuates the field contractor which applies field excitation at the point where synchronizing at the earliest possible moment can best be obtained. For reduced voltage starters, two frequency relays are used. One applies full voltage at the transfer point which may be set at any point between 40 and 80 per cent of synchronous speed. The second relay applies the field excitation when the rotor has accelerated to approximately 95 per cent of synchronous speed.

The frequency responsive relay, which is used to apply the field excitation, is in the field circuit at all times. In case the motor is pulled out of step, this



At the Barnsdall Refining Company. A 400 HP, 200 RPM, 2200 volt syncronous motor driving an ammonia compressor.



One of four synchronous motor driven ammonia compressors at a large refinery in Texas. This is a 400 HP, 200 RPM, 2200 volt synchronous motor driving a two stage double acting compressor.

relay is actuated by the induced alternating current in the field winding and the excitation is removed.

This "kick-off" feature of the frequency responsive relay allows the motor to resynchronize without interrupting service. However, this can only be done when the conditions which caused the motor to be pulled out of step have been relieved, and when the pull-in torque of the motor is sufficient to resynchronize the motor under load.

APPLICATIONS IN THE REFINERY

The oil refinery is a large user of electric power for driving process equipment and synchronous motors are applicable to a wide variety of drives in the refinery. Growing appreciation of the benefits of high power conversion efficiency, power factor correction and direct connection at slow speeds has led to the rapid adoption of synchronous motors for drives such as air, gas and refrigerating compressors, centrifugal pumps, blowers, and motor generator sets.

Before discussing the recent synchronous motor developments, let us consider the problems of applying synchronous motors to the various oil refinery applications.

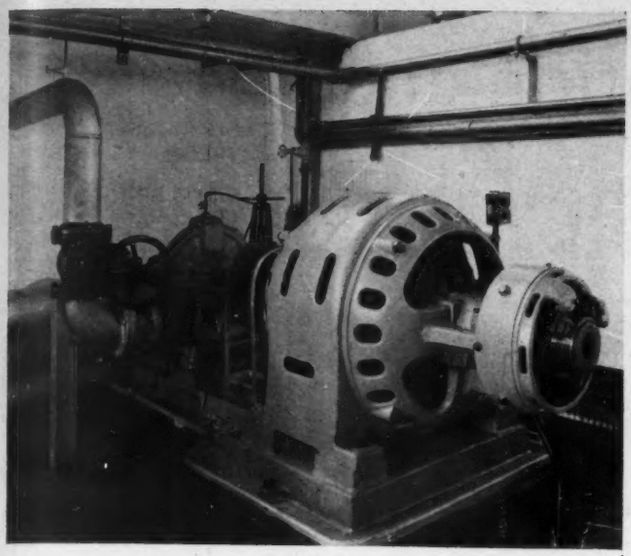
The water or oil pump drives constitute a most important application of synchronous motor in refineries. In either application dependability of the drive is an absolute necessity and the automatic resynchronizing devices on the synchronous motor control prove reliable means of obtaining continuous service.

Refining processes require large volumes of water, and the synchronous motor driven centrifugal pumps provide an economical and reliable means of supplying the water needed. Synchronous motors for driving water pumps are invariably high speed. These motors usually have sufficient starting and pull-in torques so that in case of a power dip, the motor can be resynchronized immediately when provided with frequency responsive control.

Numerous oil pumps are used in transferring the oil between storage tanks and stills, etc. Synchronous motor driven oil pumps, either centrifugal or recriprocating, mean operating economies and dependability of operation. Synchronous motors driving oil pumps require slightly different characteristics and additional safeguards than water pump drives. For reciprocating oil pumps either 450 or 600 RPM motors are used, connected through reducing gears and having normal torque characteristics. If the line is subject to power dips, 100 per cent pull-in torque should be furnished to obtain uninterrupted operation. Centrifugal oil pumps operate at high speed, usually 1200 or 1800 RPM and higher and torque requirements are easily met. In both cases, frequency responsive control provides continuous operation. Also in both cases, fire hazards due to explosions must be safeguarded. Two methods have been used to safeguard against explosions.

1. Separating the pump and motor by a fire wall and using standard equipment.
2. Installing motor and control in same room, and providing motor with enclosed ventilated and explosion resisting sealed collector rings, and using oil immersed control.

Another important synchronous motor application in the refinery is the air or gas compressor drive. Air compressors driven by slow speed direct connected synchronous motors are most economical in power consumption and dependable in operation. Air compressor applications have low torque requirements due to their ability to be unloaded during starting period. The motors are easily resynchronized after momentary power disturbances with air compressor unloader and frequency responsive con-



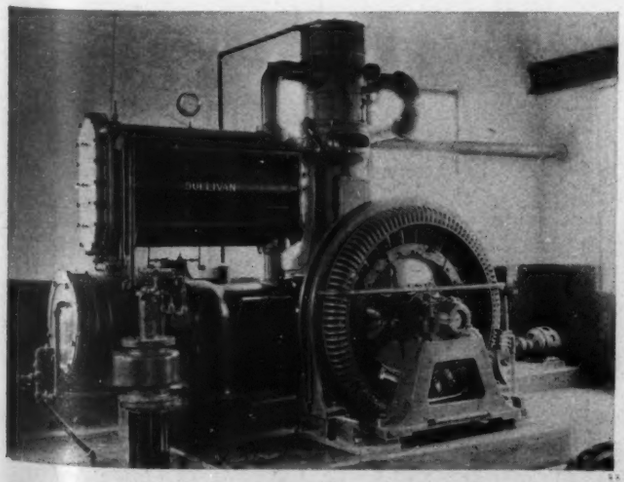
A 100 HP, 200 RPM, 2200 volt, EM synchronous motor driving a centrifugal water pump at the refinery of the Shell Petroleum Corporation in Houston

trol. The gas compressor application is often similar to the air compressor drive and the torque requirements susbstantially the same. In both applications, fire hazards are usually present and this problem can be met with as in pump applications.

In refineries where one of the products is lubricating oil, ammonia compressors are being increasingly used to provide low temperatures for removal of wax from lubricating oil. Here again the direct connected slow speed synchronous motor of normal torque characteristics and provided with automatic control and resynchronizing relays constitute an acceptable drive. Ammonia compressors provided more difficulties for unloading until the recent development of the ammonia compressor unloader which now enables the synchronous motor with normal torques to give uninterrupted service through momentary power disturbances.

Because of the lower refrigerating temperature now used in oil refinery process to obtain wax free oils, the larger ammonia compressors used are usually two stage compressors. However, a single stage compressor with booster compressor is often used. In the latter case, the horsepower and torque requirement of the application must be studied in order to obtain most reliable operation. The pull-in torque for the application is usually about 120 to 125 per cent of full load torque to permit easy synchronizing.

For handling gases at low pressures, and to provide air for agitation purposes, positive pressure blowers are often used in the refineries. The direct connected synchronous motor is an economical and dependable drive for blowers.



An angle compound air compressor driven by a 200 HP, 257 RPM, 2200 volt synchronous motor in a large refinery.

DEVELOPMENT IN SYNCHRONOUS MOTORS

The recent developments in synchronous motors and their control have resulted in greater dependability of operation. Of the recent developments, let us consider the advancement made by E-M engineers in their specialty, the synchronous motor. E-M engineers developed the full voltage reduced kv-a. starting system, which is an outstanding advancement in synchronous motor starting. Other developments in synchronous motor control include additional applications of the frequency relay, unloaders for ammonia compressors, direct current latching method of obtaining delayed low voltage release, and oil immersed vapor-proof automatic starters.

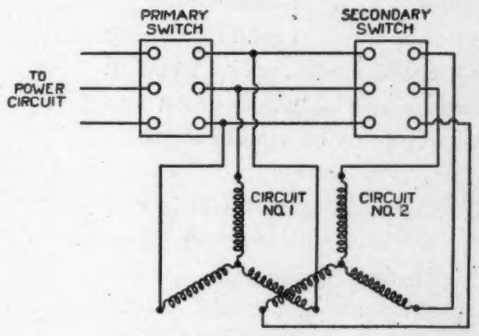


FIGURE 1

Elementary connection diagram showing switching means employed for full voltage, reduced ky-a. starting. The primary switch opens both circuits in case of overload or short-circuit.

Full voltage reduced kv-a. starting system employs parallel stator windings in such a way that better starting characteristics are obtained. The stator is divided into two or more parallel circuits. One circuit is connected to the line on starting, while the other or others, are connected at a later time during the starting period. The field frequency relay connects the second circuit or other circuits to the line at a predetermined speed during starting. Figure 1 shows an elementary control diagram.

This method of starting was developed to over-

(*Continued on page* 162)

Selection, Installation and Care of Natural Gasoline Equipment

NATURAL gasoline plant equipment proper may be broadly classified as that used for: (1) transmission of gases and vapors, (2) transportation of liquids and (3) generation of power. Other equipment requirements are those for effecting liquid and gas contact and vapor and liquid separation. Heat transfer, power generation and transmission problems constitute a large proportion of the duties of the natural gasoline plant engineer.

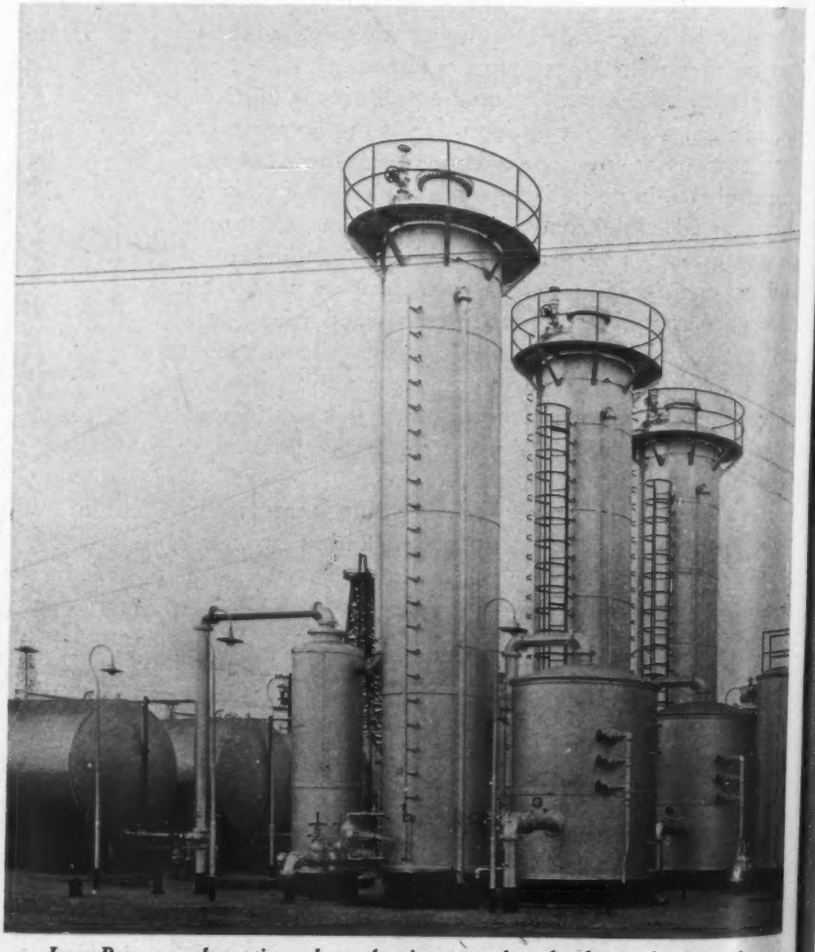
Equipment co-ordination is the secret of successful plant design; control is the key to profitable operation. There is a variety of manufactured equipment from which selection may be made, most of which is good if properly installed and operated. The trend in design is towards standardization and the manufacture of interchangeable units.

Because of uncertainties which usually exist at the time of plant erection regarding future gas supplies which may either increase or diminish in volume as well as content, during the life of the plant the demand is for gasoline extraction units of greater efficiency, wider operating range, and other accommodations to make allowance for immediate expansion or decrease in capacity.

Compact, well engineered units are a source of organization pride. Such units also have the more practical advantage of better control and require less operating labor. Some of the more recent plants are so well unified that operation is practically automatic. Control instruments co-ordinate and regulate temperatures, pressures and gas and liquid flow, with a degree of precision not possible by hand;—scientific accuracy is the rule rather than the exception.

However, despite the remarkable advances made within the last few years, the history of the industry from its beginning to the present could probably be pictorially traced in now existent plants. The excuse that antiquated equipment is too valuable to junk seems in too many instances to have greater weight than the fact that it may be too wasteful and expensive to operate.

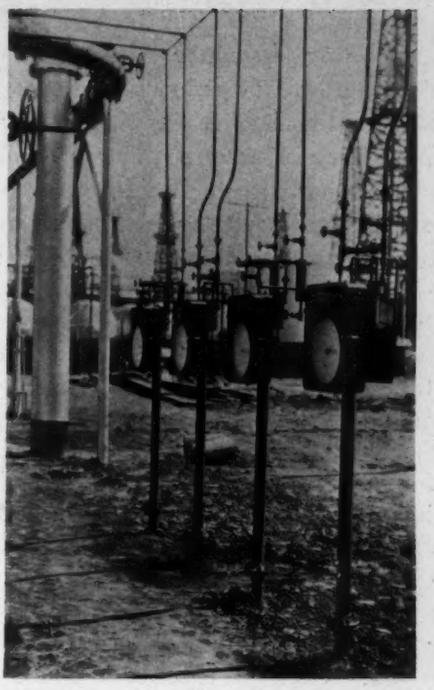
Unless the advisory engineer is cautious in his recommendations relative to the installation of new equipment in old plants, his reputation, that of the equipment and the organization he represents may suffer. By way of illustration, suppose that ab-



Low Pressure absorption plant showing complete hook-up of one unit. The Texas Company at Long Beach, California.

sorption is made more efficient by the installation of a new gas stripper, the content of the residue gas decreases but the plant production of gasoline falls away. The product also may go off end-point. The trouble most likely lies in the fractionating and condensing system rather than the absorber, as better stripping has included more of the lighter, higher partial pressure constituents, for which the former fractionating and condensing procedure are inadequate. The gains made by absorption are lost by the fractionating and condensing system, a greater percentage of heavy vapors are carried away with the increased volume of uncondensed material.

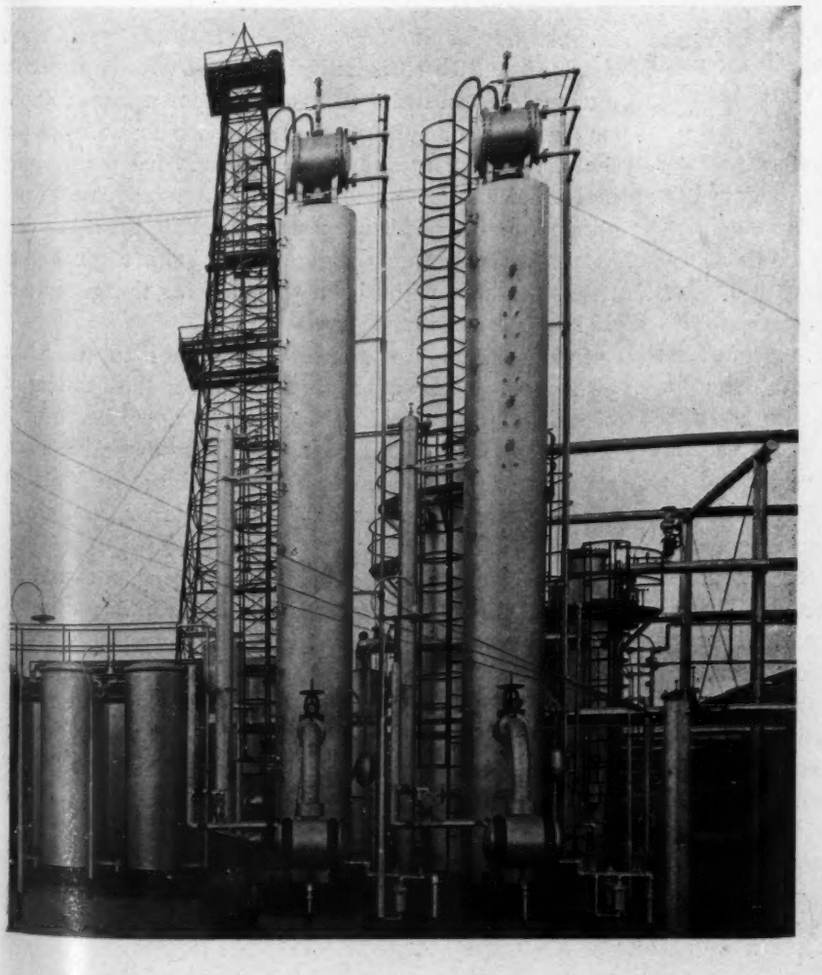
The installation of a new fractionating column may change the volume and nature of the accumulator products so much that the final rectification procedure is inadequate. Likewise changes in pressure or temperature of the condensing system may throw an impossible load on the final columns. Change from heavy to light absorption oil is not advisable unless the fractionating system is capable of close separation. All equipment and control should be co-ordinated. It is more difficult to do this in old plants than when building a new plant.



The modern gasoline plant demands a large number of control devices of both recording and indicating types in its operation.

COLLECTION, TRANSPORTATION, METERING

The gathering system is of equal importance with the extraction plant. Very frequently the gathering system with its booster stations represent a larger capital outlay than the main plant. The manufacture of gasoline begins with the gathering system.



A survey should be made and defects remedied before other changes are initiated. Depletion of gas reserves and the development of new supply territory through drilling make the strategical layout of boosters and gathering lines difficult. Some wells operate by rock pressure, others have to be pumped or vacuum applied. When new wells come in, there is usually a rush to get the additional gas supply into the plant, the equipment on hand is used for convenience and seldom or slowly replaced by other equipment more nearly meeting the requirements.

Gas-oil separators should be carefully installed and of such diameter and length as to permit settling of entrained oil, dirt, and fine sand. Gas should be scrubbed in the oil from which separated. Dirty lines result in inaccurate metering and valve trouble of compressors.

Meters should be set level, with at least two pipe lengths on either side in straight line, the orifice plates centered and perpendicular to the line of flow. Means should be provided for blowing out dirt or liquid that collects on either

side of the orifice plate. The better installations include means for by-passing the gas so that the pipe containing the meters may be periodically cleaned. The pipeline adjacent to the meter setting should provide drainage in either direction, meters are best placed on a rise. Low meter setting with the lines sloping toward the plate result in liquid settling, causing high readings. All meters should be subject to periodic inspection and the history of each recorded on a form card. Where possible it is better practice to group a number of wells through one meter. Such practice gives steadier flow, as fluctuations due to heading and pumping of individual wells tend to counteract each other. Positive meters are still used to some extent for measuring small gas flows, and the bellows principle upon which they operate requires that they be frequently cleaned, drained, and inspected.

The small friction drop through positive displacement meters makes them suitable for use in vacuum lines or for metering small quantities of gas under low pressure. It is good practice to house all metering equipment and follow the instructions given by the manufacturer. Stainless steel or other corrosion resisting materials are now extensively used for the construction of orifice plates. All orifice plates should be subject to frequent inspection and calibration. The effective pipe cross section which is also a flow factor is usually disregarded, although there is considerable variation in diameters for the standard pipe sizes. Metering has always been a favorite means of dispute between purchaser and producer, and there is a general need of more rigid regulations governing meter installation and their inspection.

Gas leakage in pressure lines may assume serious proportions. Three methods for determining leakage losses are given in U. S. B. M. Report of Investigations No. 2752 by E. L. Rawlins. These are given as (1) the "pressure drop" method (2) "metering in and metering out" method (3) the "metering in method." For accurate results the method under No. 1 is recommended. It is stated that tests can be made with "shut in" periods of one-half hour. It would seem also as if this method could be applied for testing lines under vacuum, the decrease in vacuum of a shut in line would indicate the true amount of oir infiltration over a given period. Air in gas is a more serious matter than is generally thought. Gas tests give low values as the amount of oxygen used up in corrosion is not measured. There is usually sufficient moisture present in natural gas to activate the oxygen. Dry oxygen is non-corrosive to metals. Oxygen in the presence of moisture from well brines causes pipe scale and pitting of meter plates. The finely divided brown iron oxide which collects around meters, compressor valves and constricted areas is the result of air and moisture corrosion. Much of the sludging of absorption oil is due to oxidation caused by absorbed oxygen from each cycle. For the protection of equipment every precaution should be used to exclude all air from gas. Deductions made for air content above a certain percentage do not make up for the loss occasioned by corrosion and sludged oil, not to mention reduction in the effective compressor capacity for natural gas.

Booster stations should be as centrally located to production as is practicable. Short suction lines result in higher compressor capacity. Pressure regulators in the suction lines should be placed as close as feasible to the source of gas supply under regulation, otherwise friction loss may make vacuum ineffective.

PUMPS AND PUMPING EQUIPMENT

Pumping equipment represents but a small part of total initial plant cost. Nevertheless the net overall plant efficiency is in no small measure dependent upon the smoothness and economy of liquid transfer and circulation. The paramount consideration in all equipment of this nature is dependability under every condition of continuous service. Shutdowns for repairs with consequent loss of production soon eat up any saving made by the purchase of poor equipment or slip-shod installation. Standby installations and high overload capacity are always advisable for the major requirements such as oil circulation and water for main cooling system. It might be considered questionable practice to run all the pumps from one shaft, as failure of the central prime mover will cause all circulation to be down at the same time. Steam and individual motor driven pumps have certain points in their favor as regards continuity of plant operation. Gas engine or steam turbine driven shafts should be so arranged that operation will not be interrupted. In order to avoid shutdown losses, duplicate engines or turbines either of which will operate the shaft alone are advisable. Means for disengaging individual pumps by special clutch arrangements are optional and dependent upon the specific plant requirements for circulation during repairs. Gas engines compare favorably with steam turbines for the generation of low cost power.

Such pumping equipment as belongs to the plant proper may be broadly classified under the heading of piston pumps, centrifugals, and rotary. Other miscellaneous means of liquid transfer of less extensive application include pulsometers for drainage of pits or sumps, compressed gas displacement tanks, and air or gas lift.

Piston pumps are either driven by gas expansion (steam pumps) or mechanical means. Capacities of piston pumps are expressed by the formula $Q = V (1 - \text{slip})$ where Q = capacity in G.p.m. V = net displacement of pump piston in g.p.m. and the slip is the amount lost by leakage. Steam pumps may be further classified as of the condensing and non-condensing type. The non-condensing types are suitable for gas drive from a pressure line as well as steam.

There are two methods of speed control, i.e., throttling by a valve in the steam line and by use of auto-

(*Continued on page* 166)

Trap draining steam line to hot oil pumps.

Design and Operation of Steam Traps

By T. H. REA
Armstrong Machine Works

BY definition a steam trap is an automatic valve for removing the water of condensation from a steam line without the loss of any live steam. Both functions are of equal importance. That is, the condensate must be removed and no steam can be allowed to escape. A trap that fails to operate when condensate is in the line is worse than no trap at all, while a trap that blows steam is no batter than a cracked valve that costs a whole lot less.

If steam at 100 pounds pressure is allowed to escape through a 3/16-inch diameter discharge orifice, in one month's time 113,000 pounds of steam will be wasted. At 60 cents per 1000 pounds, this represents a loss of $67.98 per month.

A comparatively small refinery will have from 200 to 500 traps installed while a large refinery may have as many thousand. The orifice size and steam pressure just specified may be considered average for re-

finery service and the potential steam loss through the orifices of these traps represents a considerable sum.

The average cost of a steam trap installed on the job in a refinery is probably in the neighborhood of $25.00. This figure includes the cost of the trap delivered at the refinery, the cost of the fittings for installing, and the labor cost. This brings the trap investment in medium sized and large refineries anywhere from $5,000 to $75,000.

Thus from the standpoint of first cost as well as potential loss from faulty operation, the selection of steam traps for refinery service is a question that should receive careful attention by refinery engineers. Likewise, once the traps are installed they should have the inspection and care to which any piece of automatic equipment is entitled.

TRAP TYPES

Steam traps are usually classified according to the type of mechanism governing the operation of the discharge value. The five types of traps in common use are thermostatic, tilting, closed or ball float, upright bucket, and inverted bucket. As the name implies, thermostatic traps depend on temperature differences for operation. The other types listed are gravity operated traps in that the difference between the specific gravity of steam and water is the force that actuates the discharge value.

Regardless of the type of mechanism used to control the steam trap valves, the capacity of the trap is definitely limited by the diameter of the discharge orifice and the pressure differential through the trap. This maximum discharge capacity will be decreased if the valve stem is not pulled far enough away from the seat. Likewise if the inlet or discharge passages are complicated, the pressure differential through the orifice will be decreased which will cut the capacity just as though the steam pressure were lowered. However, the diameter of the

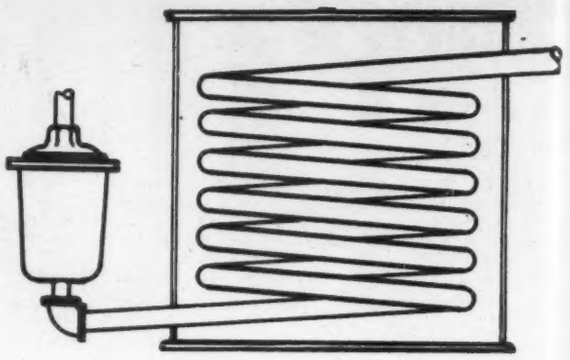


FIGURE 1

discharge orifice has by far the greatest bearing on capacity and as a general rule, traps should be purchased on the basis of orifice sizes rather than pipe connections.

All traps will prevent the loss of live steam as long as the discharge valves are tight and the operating mechanism is in sufficiently good condition to control the valve. Thus the question of steam loss is largely one of valve design and material.

The cutting effect of steam known as wire drawing is most pronounced when the valve is barely cracked away from the seat. For this reason wire drawing is minimized in traps of the intermittent discharge type because the valve is either wide open or tight shut. A water sealed valve will last longer than one that must hold tight against steam. The cutting effect of water is much less than that of steam at the same pressure because steam will pass through a minute crevice at a much higher velocity than will water. The high velocity of the water particles carried along with the steam seem to cause the cutting or wire drawing. Last, but not least, the durability of steam trap valves can be increased by the use of high quality materials. During the past few years, the stainless steel valve parts have rapidly grown in favor because of its non-corrosive proper-

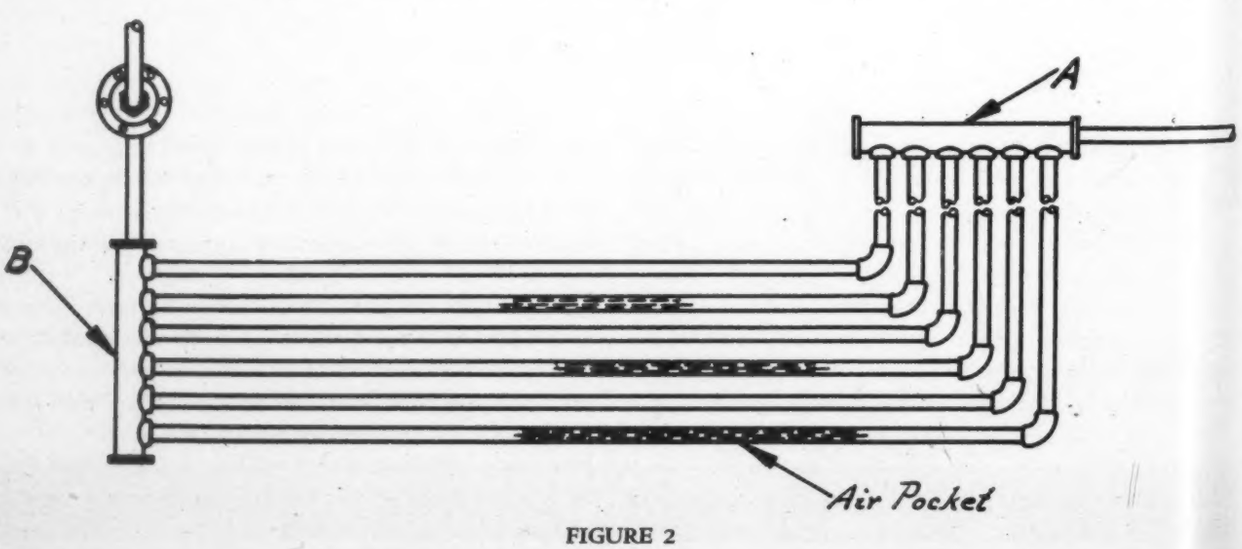


FIGURE 2

ties as well as the extreme resistance to wire drawing.

Of equal importance to capacity and prevention of steam loss, a steam trap must be reliable and be able to operate for long periods with a minimum of attention. This is especially true of refinery service where the rush of special work makes it impossible to give traps the same regular attention that they obtain in the average industrial plant.

Until recent years, air binding was considered a necessary evil in steam traps. To get rid of the air pet cocks were used, but this entailed a considerable steam loss along with the air. An improvement over the air cock is the hole drilled in the discharge tube of upright bucket traps that enables the trap to discharge some air with each discharge of water. The vent in the top of the bucket, used in traps of the inverted bucket type, permits the escape of air without the loss of any steam. Also the trap will discharge air even though there may be no condensate coming to the trap.

Sediment and sludge as well as oil and grease will interfere with trap operation. Unless trap used is of the type that will automatically removed these impurities, the traps should be periodically cleaned out or blown down. Otherwise continuous and satisfactory operation cannot be obtained.

Most trap manufacturers rate their traps on the basis of continuous discharge capacities. Since a trap that discharges continuously is very evidently overloaded, ample allowance must be made for intermittent operation. Likewise the drop in pressure to the trap must be taken into consideration and also the back pressure in the return line.

Traps for draining steam purifiers and steam separators must have ample capacity to handle the maximum amount of water that may be thrown over by the boiler. If there is a tendency for the boilers to foam or prime more capacity must be provided than is the case when water conditions are more favorable. If the separator or receiver has a lot of storage capacity a smaller trap can be used than if the trap has to remove the water as fast as it comes to the separator. Traps for draining steam distribution mains should also have ample capacity to take care of emergency loads. When superheated steam is used, the traps ordinarily have to handle only the water that is condensed when steam is first turned into the line. Unless superheat is lost or water is thrown over by the boilers, the trap has nothing to do. Hence traps on such installations amount to an insurance policy, so the greater the risk the greater the premium should be in the shape of trap capacity.

PROCESS NEEDS

In contrast to steam traps for emergency installations, as described in the proceding paragraph, traps for process work do not require such a large margin of capacity. With the maximum amount of condensate known, the selection of a trap is a relatively simple matter. Let us assume that a submerged coil is supplied with steam from a 100-pound pressure steam header and that the coil will condense 2000 pounds of steam per hour. Would a trap having a continuous discharge capacity of 2500 pounds of water per hour at 100 pounds pressure have enough capacity for the job? Not at all. In the first place when the coil is condensing 2000 pounds of steam per hour, the pressure drop through the coil will materially lower the pressure at the trap. Perhaps the pressure will be only 80 to 90 pounds. Then, too, there is usually a variation in pressure in the supply header and the trap should handle the job when the pressure is at the minimum. Also there is bound to be pressure in the return line due to the flash steam from the discharged condensate. Thus the actual pressure drop through the trap may, under extreme conditions, be as low as 60 pounds and the trap that will handle 2500 pounds of water at 100 pounds pressure will not handle anywhere near that amount at 60 pounds pressure. In fact a trap that is rated to handle 4000 pounds per hour at 100 pounds pressure would be about right for the job.

The percentage of excess capacity that must be provided in a steam trap for process or heating work depends upon three factors. First, the amount of air that the trap has to handle. When a trap is handling air, its capacity to remove condensate is reduced somewhat so excess capacity must be provided. Second, the gravity drainage of condensate to the trap. Third, the possibility of short circuiting through portions of the radiation.

If the exact amount of condensate could be known, a steam separator would be the easiest sort of unit to drain with a trap. Air is no problem as the separator is not a dead end and any air would be carried along with the steam. As soon as enough water collects in the separator to cover the line to the trap, no steam can get to the trap and as a result the trap will discharge continuously until the water is removed. The gravity drainage is perfect and there is no chance for short circuiting.

Let us assume that the submerged continuous coil 10 feet long and one inch in diameter shown in Figure 1 will hold 103 cubic inches of air and will condense 600 pounds of steam per hour at 100 pounds pressure. When steam is first turned on, the small amount of air is quickly discharged through the trap and the gravity drainage of condensate is aided by steam flowing to be condensed in the lower part of the coil. Very little excess capacity has to be provided for such a coil as there is very little air to handle and the gravity drainage of condensate is nearly perfect.

Now an ordinary heating coil to condense 600

pounds of steam per hour at 100 pounds pressure would require some 1016 lineal feet of two-inch pipe. This pipe would contain 24 cubic feet of air which is almost 400 times as much air as contained in the submerged copper coil described in the preceding paragraph. The extra air that must be removed requires a trap with more capacity than is necessary for the submerged coil.

If the 1016 lineal feet of two-inch pipe consisted of a practically horizontal continuous run of pipe, a trap having a capacity in excess of 1800 pounds of condensate per hour should be installed. Such a long line of two-inch pipe would be very unusual and the radiation is more likely to consist of several lines of pipe connected to a common header as shown in Figure 2. The drainage of such a coil may be further complicated by short circuiting. Air pockets frequently form as indicated in the drawing. This is due to a number of causes such as unequal length of pipes permitting steam to get to header "B" through some pipes before all the air is out of the other pipes. The steam shuts the trap and the air is pocketed by steam entering the lines from header B. These air pockets reduce the amount of steam condensed in the coil and usually the trap gets the blame. If an oversized trap is installed on the coil, there may be a slight pressure drop in header "B" that tends to pull the trapped air from the pipes.

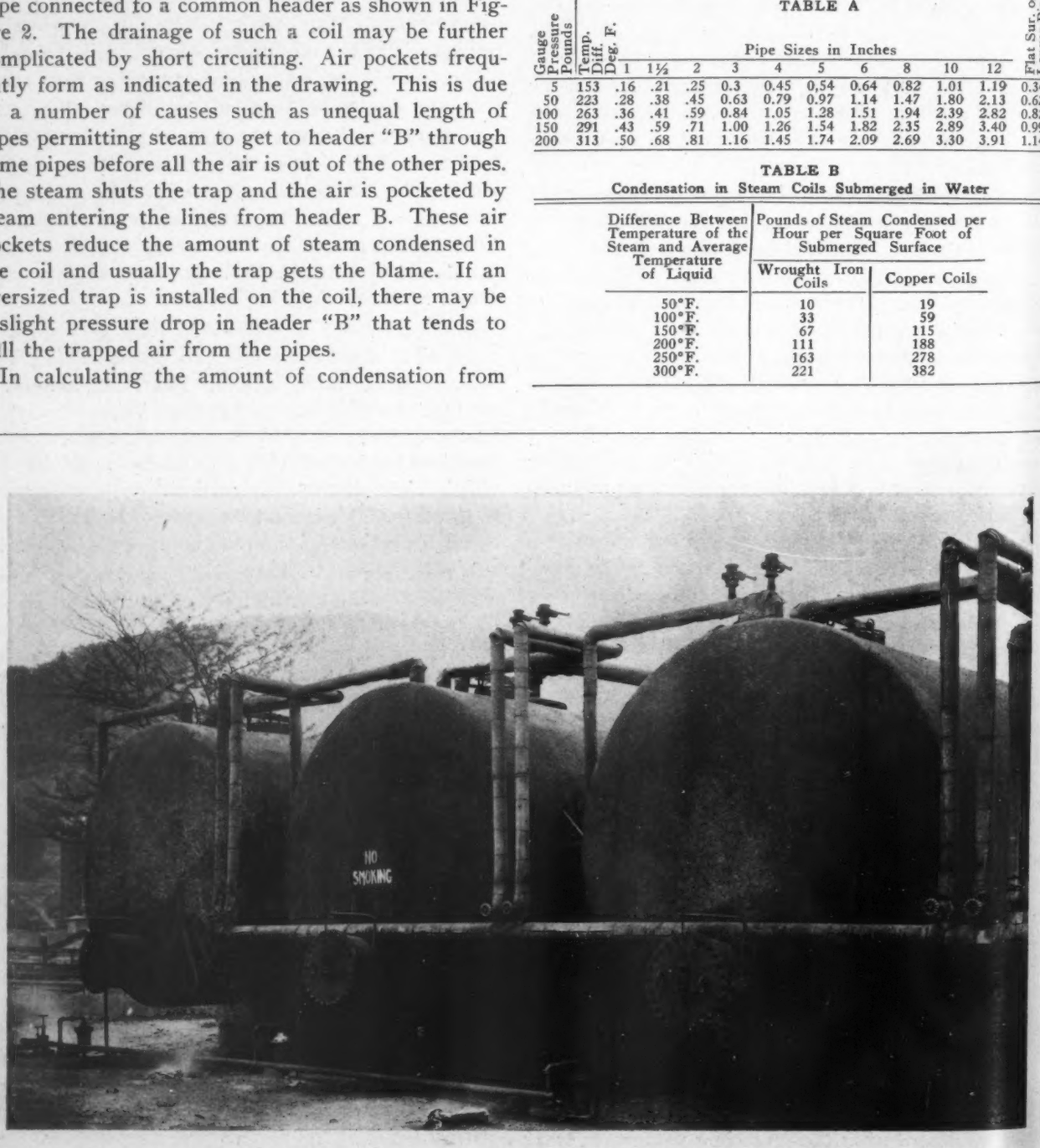
In calculating the amount of condensation from process radiation the following tables will prove helpful. Table A shows the pounds of condensation per hour per lineal foot of pipe or square foot of radiation at various steam pressures and temperature differences. Table B indicates the condensate that can be expected from submerged coils of iron and copper at various temperature differentials. The figures in Table B assume that the coils will remain clean and bright. If the coils are apt to become fouled the figures should be divided by two. Likewise where thick viscous liquids surround the coils the condensation figures should be divided by at least four and in extreme cases divided by 10.

TABLE A

Gauge Pressure Pounds	Temp. Diff. Deg. F.	Pipe Sizes in Inches										Flat Sur. or Larger Pipe Per Sq. Ft.
		1	1½	2	3	4	5	6	8	10	12	
5	153	.16	.21	.25	0.3	0.45	0,54	0.64	0.82	1.01	1.19	0.34
50	223	.28	.38	.45	0.63	0.79	0.97	1.14	1.47	1.80	2.13	0.62
100	263	.36	.41	.59	0.84	1.05	1.28	1.51	1.94	2.39	2.82	0.82
150	291	.43	.59	.71	1.00	1.26	1.54	1.82	2.35	2.89	3.40	0.99
200	313	.50	.68	.81	1.16	1.45	1.74	2.09	2.69	3.30	3.91	1.14

TABLE B
Condensation in Steam Coils Submerged in Water

Difference Between Temperature of the Steam and Average Temperature of Liquid	Pounds of Steam Condensed per Hour per Square Foot of Submerged Surface	
	Wrought Iron Coils	Copper Coils
50°F.	10	19
100°F.	33	59
150°F.	67	115
200°F.	111	188
250°F.	163	278
300°F.	221	382



Installation, Care and Maintenance of Pumping Equipment

By F. B. APPLEGATE
Manager, Direct Acting Pump and Heater Division,
Worthington Pump and Machinery Corporation

THE installation, care and economical maintenance of the pumping equipment used in the oil industry is a subject which, to treat adequately, would require all the space between the covers of this magazine. We will assume that the pump has been properly selected for the service it is to perform and that our problem is first to install it properly to perform that service.

The first consideration for a good installation is the proper location of the pump in relation to its source of supply. That is, will the pump be located above or below its source of supply? Will it be close to that source or at some distance from it? Will the liquid to be pumped be at a temperature above or below its vapor pressure? These points are of paramount importance in laying out the suction line and in properly locating the pump so that it will perform the desired service without trouble. Unquestionably, more operating troubles are traceable to the improper location of the pump in relation to its source of supply and to poorly laid out suction lines, than to any other causes.

To better understand this, let us analyze what takes place on the suction side of a pump in order to determine why the liquid flows into the suction of the pump. When a pump is located above the liquid being pumped, it is said to have a suction lift and we think of the pump as lifting the liquid, but what actually takes place is that the action of the pump piston or plunger by displacing some of the air in the suction chamber of the pump causes the pressure to drop below that of the atmosphere. The pressure of the atmosphere on the surface of the liquid being greater than the pressure in the suction chamber of the pump, causes the liquid to flow into the pump. Therefore, when the pump is located above its source of supply, all we can depend upon to fill the suction chamber of the pump is the pressure of the atmosphere which is 14.7 pounds per square inch at sea level and less at altitudes above sea level.

If it were possible to create a perfect vacuum in the suction side of a pump and there were no air, gas or vapor in the liquid, it would be possible to attain a suction lift equivalent to 34 feet of water.

In actual practice this condition is impossible for the following reasons:

(1) The pump cannot create a perfect vacuum due to small air leaks through stuffing boxes and gasketed joints.

(2) The liquid that is to be pumped will give off entrained air or gas in a vacuum.

(3) Volatile liquids such as gasoline, etc. will vaporize even in a low vacuum.

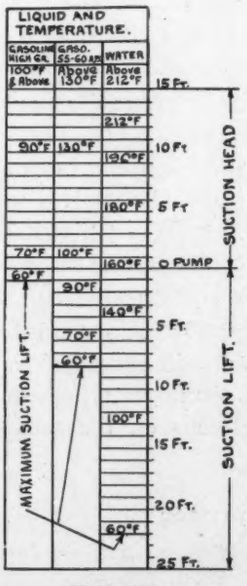


FIGURE 1
Practical suction lift and required suction head for different liquids at various temperatures.

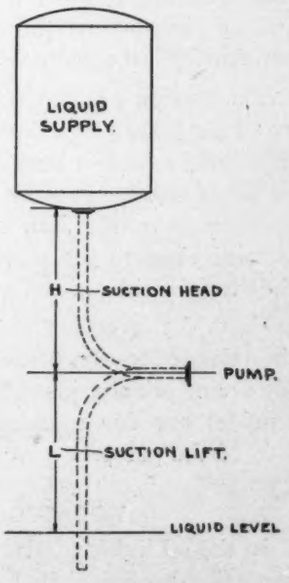


FIGURE 2
Illustrating suction lift and suction head.

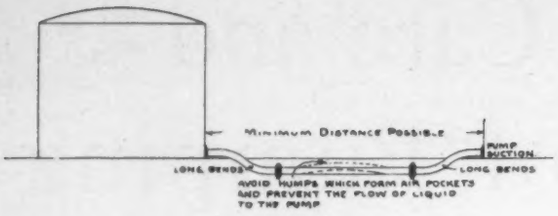

MINIMUM DISTANCE POSSIBLE
PUMP SUCTION
LONG BENDS
LONG BENDS
AVOID HUMPS WHICH FORM AIR POCKETS AND PREVENT THE FLOW OF LIQUID TO THE PUMP

FIGURE 3

Arrangement of long suction line. For best results keep suction line level or slope toward the pump.

(4) Small air leaks through the joints of the suction pipe.

(5) The friction of the liquid flowing through the suction pipe.

All of these factors combined, limit the practical suction lift to an equivalent of 22 feet of cold water for steam or power driven displacement pumps, and 15 to 18 feet for centrifugal pumps. Special conditions may exist where these suction lifts may be exceeded, but for the average installation the foregoing limits should be followed.

Liquids that will vaporize at atmospheric temperatures when under a low vacuum must flow into the suction of the pump by gravity; otherwise, the vapors released in the suction line will either reduce the capacity of the pump or may destroy the suction entirely and the pump will not deliver any liquid at all.

When liquids are heated to a temperature equal to or above their vapor point, they must flow into the pump under a static head that is sufficient to prevent the formation of vapor in either the suction line or the suction chamber of the pump. If this static head is not provided, the pump will not function.

The suction pipe must be carefully planned so as to avoid air or vapor pockets. When necessary to use fittings in the suction line, always use long radius elbows or better use long radius pipe bends. Gate valves will give better results than other types. When a reducer is used close to the pump, an eccentric reducer with the straight side on top gives the best results.

From the foregoing it can be readily understood that the relative location of the pump and its source of supply are of primary importance, as the majority of pump troubles are due to faulty conditions on the suction side of the pump.

LOCATION OF PUMPS

In the oil industry, the service a pump is to perform generally determines its location. Pumps for field service are generally located in the open and are mounted on skids. Make the skids substantial and whenever possible a shelter of some kind should be placed over the pump to keep dust and dirt out of the bearings and other moving parts in order to reduce wear and maintenance cost. Refinery and line station pumps, being permanent installations, should be set on well-built concrete foundations and properly housed. Refinery and line station pump houses should be well ventilated and well lighted to permit periodical inspection. Equipment will be given more attention and better care when it is "get-at-able" and the operator can easily see what is required to keep it in first class condition.

STARTING A NEW PUMP

Many manufacturers over-emphasize simplicity of construction and operation of pumping equipment. It is true that a modern pump is simple in construction and requires the minimum amount of attention; nevertheless it requires care and attention during the breaking-in period. Like all new machines, a new pump will be stiff and should be operated at a slow speed or under a light load until all bearings and packings are properly adjusted. This will greatly prolong the life of the wearing parts and save costly repairs. Briefly the principal points to keep in mind when starting new pumps are:

Lubricate the steam cylinders before starting, to prevent possible scoring. This may be accomplished by removing the cylinder heads, steam chest covers or by operating the mechanical lubricator by hand. After filling the stuffing boxes evenly with a good grade of packing, tighten the stuffing box nuts with the fingers. After the pump is operating, take up the nuts slowly and evenly using care not to bring them up too tight or the rods or plungers will be scored.

With the pump operating slowly, bring it up to full operating pressure by gradually closing the valve in the discharge line and take up all nuts that may have become loosened during shipment, check wearing parts and packing once more to make sure there is no binding, and pump will be in condition to operate at full load.

CENTRIFUGAL PUMPS

After suction and discharge pipes have been bolted up, recheck the alignment of the pump and driver, also the clearance between the faces of the coupling so they cannot strike, rub or pull on either the pump or its driver.

Make a final inspection of bearings to be sure they have been thoroughly cleaned and filled with lubricating oil. See that stuffing box packing is properly installed and glands properly adjusted so that packing will not

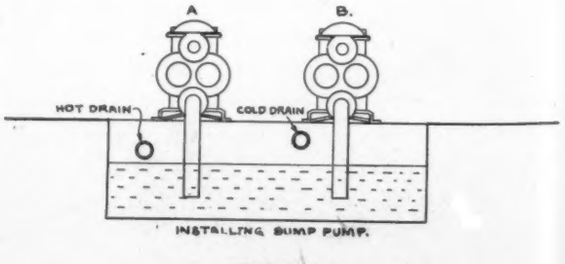


FIGURE 4

Avoid locating pump at A. Hot drains may destroy suction lift and cause pump to race and pound. Locate pump away from hot drain as at B.

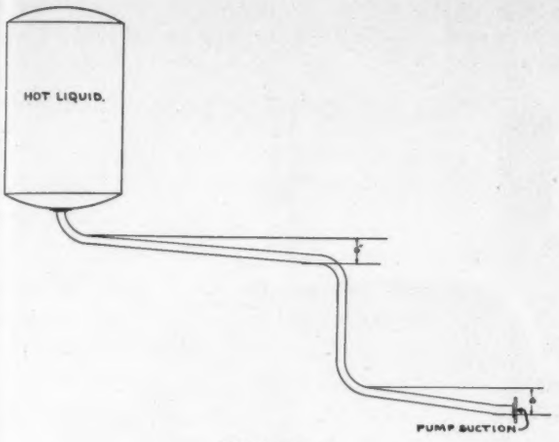


FIGURE 5
Arrangement of long suction line for hot liquids. Note slope in line to eliminate vapor pockets.

cut the shaft sleeves and sealing connections are made to the stuffing box sealing ring and are open.

Close the discharge valve, prime the pump, apply speed rapidly so that head is generated quickly to expel air or vapor entrained in the liquid. After a pressure is built up on the discharge, open the discharge gate valve slowly. After pump is started for the first time, watch the stuffing boxes, pump bearings and the bearings of the driver for overheating. If the pump and driver have been properly lined up and the bearings adjusted and lubricated, no trouble will be experienced.

When starting power driven displacement pumps for first time, observe the same precautions as for centrifugal pumps. Power pumps, like simplex or duplex direct acting pumps, are self-priming. It is best to operate them at first at reduced speeds and reduced heads while making final adjustments of packing glands and bearings, after which the pump may be brought up to full speed and pressure.

A little extra care when first starting will save expensive repairs and shut-downs later.

CARE AND MAINTENANCE

Periodic inspection forms the basis of the proper care and maintenance of pumping equipment. Systematic inspection will prolong the life of the equipment, reduce maintenance cost, insure the most efficient operation and prevent costly shut-downs.

Checking the operation of lubricating devices, levels in oil reservoirs, tightness of stuffing boxes, condition of rods or plungers and the condition of gaskets should be the basic points of periodic inspection. In small plants and field installations, the operators should be instructed to do this as an essential part of their duty. In the larger refinery installations, the inspection should be assigned to men whose sole duty is to inspect all pumping equipment, instruct operators to make necessary minor adjustments at once and to report promptly to the maintenance engineer all equipment that requires attention beyond that which can be reasonably given by the operators.

Thousands of dollars are wasted annually for unnecessary repairs, valuable raw and refined products are wasted, excessive cost for packing is incurred and valuable production time lost because of the lack of periodic inspection. Major breakdowns are seldom due to accident or to inherent weakness of design or strength of pumping equipment, but are due to lack of care and proper inspection of the equipment.

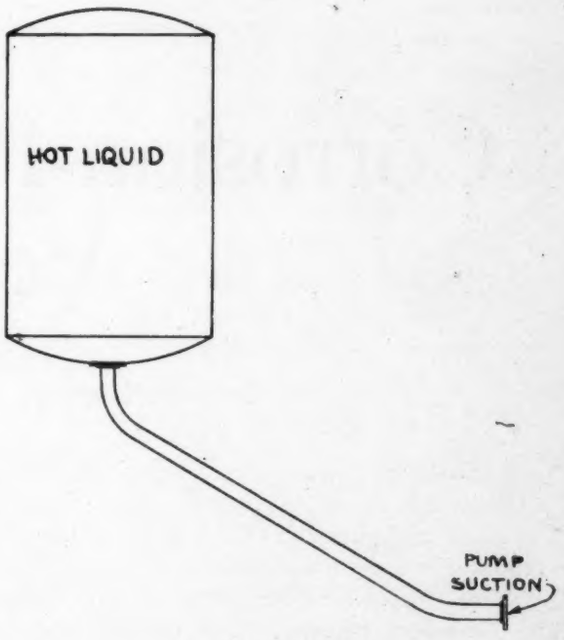
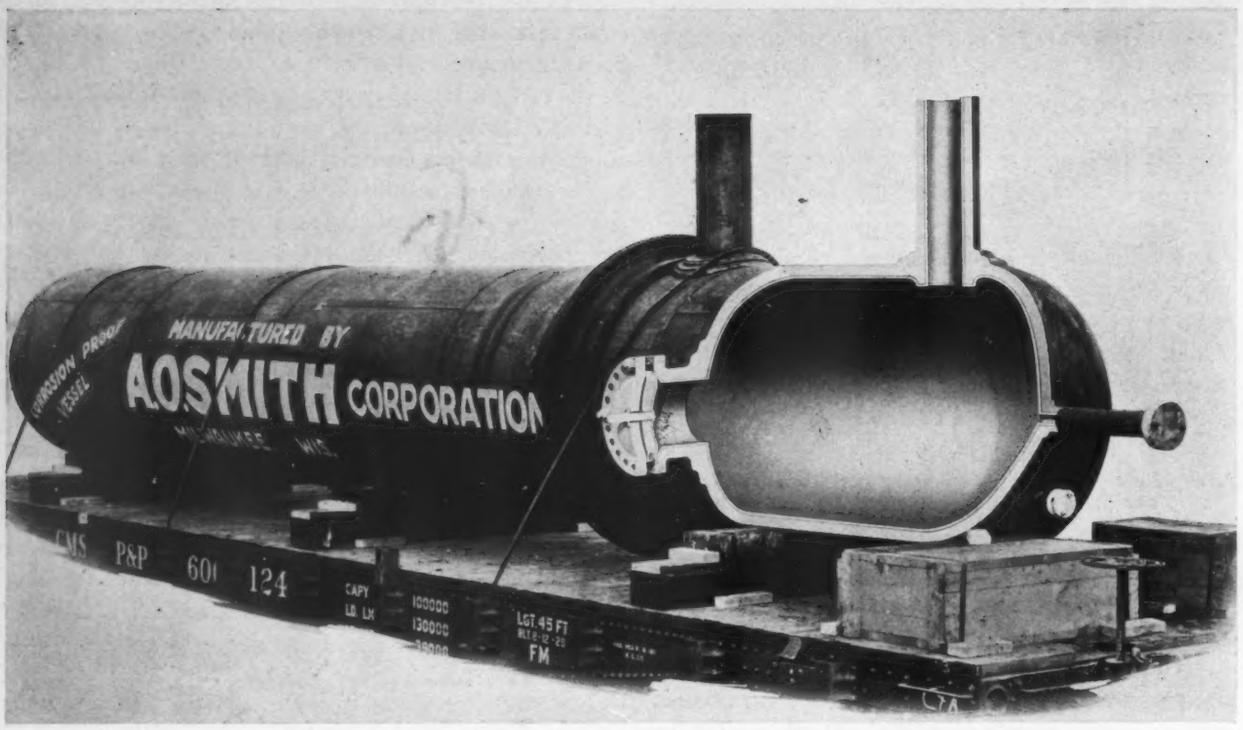


FIGURE 6
Arrangement of short suction line for hot liquids.



Cut away section of still, showing extent and method of lining.

Corrosion-Proof Pressure Vessels

By O. E. ANDRUS
Research Engineer, A. O. Smith Corporation

CORROSIVE crudes have long given the oil refiner plenty of problems, usually met by adding enough metal to the vessel walls to insure reasonably long life of the equipment. Since A. O. Smith Corporation began manufacture of oil cracking chambers, its research department attempted to retard this corrosion by coating with alloy weld deposit the interior surfaces, particularly such parts as proved to be most susceptible to attack. The aim was to produce mechanical strength and physical reliability with dependable carbon steel and to produce longevity and chemical inertness by properly bonding a thin layer of suitable alloy to the carbon steel surface.

This method, while successful, is too costly for general application. Another method was therefore developed following several years of extensive research, which permits the lining of entire vessel interiors with a corrosion-proof alloy. This construction employs sheet alloy, which is bonded to the carbon steel so as to make the lining an integral part of the vessel wall, including heads, manways, nozzles, etc. The alloy lining is usually about 12 gauge. Besides reducing costs to a commercial possibility, it thus became practical to meet various corrosion problems with suitably protected carbon steel vessels.

After considerable large scale development, production work began and by the end of 1930, three large Smith lined cracking stills were in high-pressure, high-temperature operation. These vessels range in wall-thickness from three inches to 5½ inches and each is lined with 12-gauge chrome-nickel iron of the 18-8 class. Other lined vessels are under

construction and the study of the use of various alloys for lining is well advanced for many other services.

PHYSICAL PROPERTIES OF LINING

A shearing strength of 8000 to 15,000 pounds is developed in the bond joining the sheet alloys to the carbon steel.

The first necessity of a lining is its ability to remain attached to the vessel. This quality has been lacking in previous attempts because proper heat transfer between the steel walls and the lining was not established, thus allowing large temperature differences to prevail with resulting destructive stresses. Unless the temperature difference between the lining and the adjacent portion of the shell is kept sufficiently low during periods of temperature change in the vessel, rupture is certain to result. The success of Smith lining lies in the exclusive bonding method, which makes the sheet alloy practically an integral part of the vessel, insuring the maintenance of small temperature differences throughout. This close bonding also assures the ability of a Smith lining to transfer processing heat, which in some services is decidedly necessary.

The lined vessel is so designed as to prevent appreciable stresses in the carbon steel walls under service conditions. Calculations based on the physical properties of the materials at elevated temperatures indicate that the stresses produced by a 7/64 inch chrome-nickel (18-8) liner in a vessel with a two inch thick carbon steel wall are below 1200 pounds per square inch under the most adverse conditions found in oil refining practice. The 18 per cent chrome steels will introduce even lower stress in the carbon steel wall.

It is also to be remembered that the wall thickness of a corrosion-proof lined vessel remains constant, while an ordinary carbon steel vessel gradually becomes thinner as the steel corrodes away. Thus, in the carbon steel vessel the stresses will be ever increasing and in time are likely to greatly exceed the comparatively small stresses in the 18-8 lined structure. As a matter of fact, the strength of a lined vessel is greater than that of the unlined, both vessels having carbon steel walls of equal thickness.

CHEMICAL PROPERTIES

The particular alloy to be used in each case for the lining of a pressure vessel will, of course, depend entirely on what service it is required to meet. So far, mostly chrome and chrome-nickel alloys have been tried, but the application is not limited to this group.

Several years have been devoted to the study of corrosion problems encountered in the refining and cracking of oil. For that length of time certain parts of Smith welded oil stills have been protected with alloys containing 18 per cent chrome or the 18 per cent chrome — eight per cent nickel combination. Both materials have proven entirely satisfactory and show no visible signs of physical or chemical deterioration under the service mentioned. This substantiates laboratory tests, which indicate that a 7/64 inch lining should outlast six or more inches of steel.

APPLICATION IN THE REFINERY

It is obvious that any new developments must be considered not only from the technical viewpoint, but also in the light of economics. A study of all factors affecting costs, length of life, etc., is therefore of great importance. In the case of a lined vessel, the oil refiner must balance at least the following four factors against the added cost of lining:

1. Cost of replacement and repairs, (material, direct and indirect labor).

2. Shutdown costs for such replacements and repairs, (overhead expenses and lost production profits).

3. Loss in process efficiency due to decreasing wall thickness, (drop in conversion yields, throughput and flexibility).

4. Hazard costs incidental with corroding equipment (insurance, morale and efficiency losses).

If the refiner is already attempting to protect his vessels in some way, he must add to the above items, the cost of the protective installations and the repair or renewal expenses in that connection.

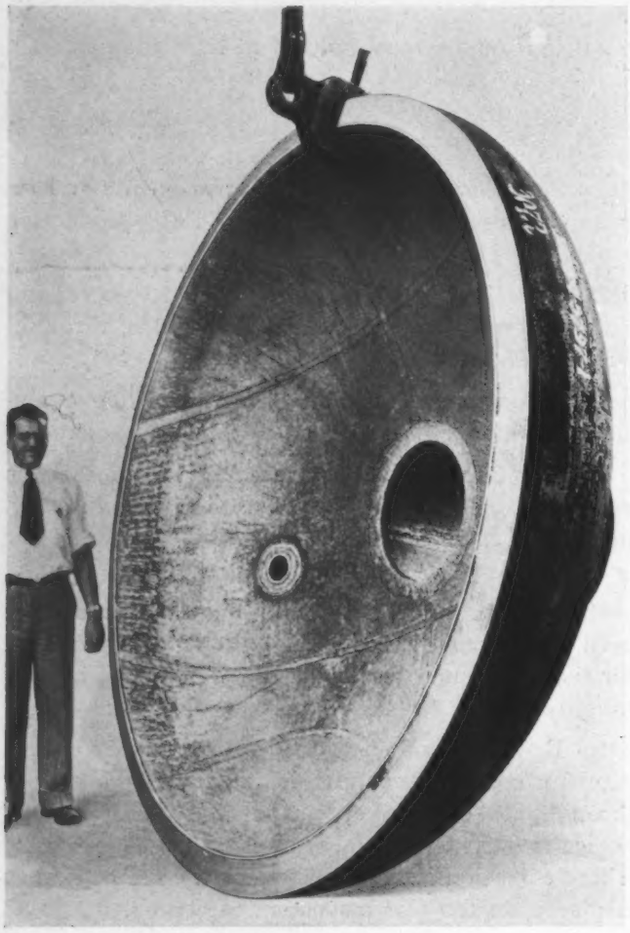
Heretofore, a number of different methods were used to combat corrosion and others were proposed for the same purpose. Such methods can be classed roughly in five different groups as follows:

1. Reduction of operating pressures to compensate for corrosion, results in appreciable losses in throughput, conversion yields and flexibility in choice of oils. The element of hazard is considerable where corrosion is severe, particularly when reliance is placed on too few inspection measurements.

2. Increase of initial wall thickness to compensate for corrosion, results in high costs (steel is an expensive element when used to satisfy badly corrosive oils). When non-uniform corrosion is allowed to take place over considerable depths, a bad condition of uneven working stresses may result. It is no longer a good policy to equip refineries with vessels which are limited to good charging stocks since market and transportation changes may necessitate the use of medium or bad charging stocks.

3. Non-metallic liners, although not one hundred per cent satisfactory, have become popular because of their superiority over previous methods. The installation, repair and renewal cost sums up to a large figure over a period of years. The life is short and erratic, necessitating appreciable shutdown periods. The uncertainty of bond produces non-uniform cor-

rosion which is somewhat difficult to detect accurately. Since a vessel is only as strong as its weakest point, pressure drops with resulting losses in yield, throughput and flexibility must result. The coatings are quite susceptible to injury. Their heat insulating effect makes cleaning, inspection and recabling jobs longer, more expensive and quite disagreeable. Although this method of protection possesses shortcomings along with a high cost, it deserves credit as having been one of the most satisfactory and economical solutions to date.



Smithlined head for coking drum.

4. Addition of lime or caustic is fairly effective in the furnace tubes and chambers, but not entirely so beyond the distillation point. Since quantities considerably in excess of theoretical are necessary, the cost is high, difficulties often appreciable, and the removal of slow settling suspensions from fuel oils expensive and troublesome.

5. The remaining methods are not very popular largely because of their accumulative cost or inadequacy. These include thin coatings of metal as chrome plating and metal spray or coatings in the category of paints. In general, they are too thin, being subject to porosity and mechanical injury.

SOUGHT CORROSION SOLUTION

The Smith lined vessel was developed with the aim of obtaining an ecenomic solution to the corrosion problem—at the same time eliminating the various weaknesses inherent with past practices and briefly touched upon above. The main objects of the development can be listed as follows:

1. Relief to the refiner of the ever present fear of serious pressure vessel fires and explosions with accompanying loss of life and property; 2. a completely adequate vessel for long service rather than one which must be revamped at the very start and from time to time thereafter; 3. elimination of "pressure dropping" practices with accompanying drops in conversion yield, throughput and charging stock flexibility; 4. maximum reduction in length of shutdown periods; 5. a coating which will stand all the abuses given the unlined vessel without danger of removal of protection through spalling or undercutting; 6. a vessel possessing a constant known strength rather than a varying strength difficult to ascertain without further weakening the vessel with inspection scars; 7. a coating which will not heat insulate all or part of a vessel, thereby causing appreciable stresses during heating and cooling periods, and causing slowness of cooling during cleaning periods with resulting time loss and dismfort; 8. a method of protection which causes no obstructions to flow and which does not result in contamination of by-products; 9. a vessel which is easily inspected at any time without necessitating the removal of protective coatings; and 10. possibility of maximum market advantage through ability to use the most corrosive stocks with safety and profit.

APPLICATION IN CHEMICAL INDUSTRIES

There are numerous possibilities for the lined construction in the various chemical industries. It may serve as a structure to eliminate staining of contamination of products, to insure safety against the ravages of corrosion, to serve as a hydrogen retaining seal, to substitute for a less reliable alloy construction having questionable physical properties, or to gain economic advantages over thick-walled alloy structures.

Since there is no one material which is a cure-all for all corrosive mediums, it becomes necessary to make tests to determine the correct material. Although the laboratory may be able to predict the resistance to corrosive mediums, it is always desirable if not necessary to make immersion tests of lined specimens directly in the manufacturing retorts, digesters, stills, tank cars, etc. This method of testing is the one and only way of insuring that all factors are taken into account in proportion of their importance.

Measurement and Control Heating Effects of Gases

By A. E. KROGH
Development Engineer, Brown Instrument Company

IN recent years there has come about a closer cooperation and interlocking of interests between utility companies, oil refineries, and producers. The large quantity of fixed gas produced in oil refining operations, the recent development of liquid gas processes, and the further extension of the natural gas pipe lines, all have combined to make the interests of the gas companies and those of the oil companies similar.

It is thus reasonable to suppose that oil concerns in general will wish to know about a recent development of an equipment which will measure and control the mixture of the gas supplied to domestic consumers, and the manner in which the gas will burn. It is well known that gases of different composition, though of the same heating value do not burn similarly. The classic example of this can be easily demonstrated by trying to burn carbon monoxide and hydrogen under similar conditions. It will immediately be observed that the natures of the two flames are quite different and that the heating effect of the two gases will not be the same, although the heating value of each gas is 325 B.t.u. per cubic foot.

The effectiveness of a combustible gas when burned in any burner depends upon the characteristics of the burner, the pressure of the gas, its heating value, and its rate of flame propagation. In order to give the maximum efficiency, the heating value of the gas must be kept within moderate limits, but the rate of flame propagation should not be permitted freely to vary. It is much better to vary the heating value slightly in order to hold the total effectiveness of the gas constant.

The many types of calorimeters, automatic and non-automatic, which are on the market, will measure and control the heating value of gas supplied to

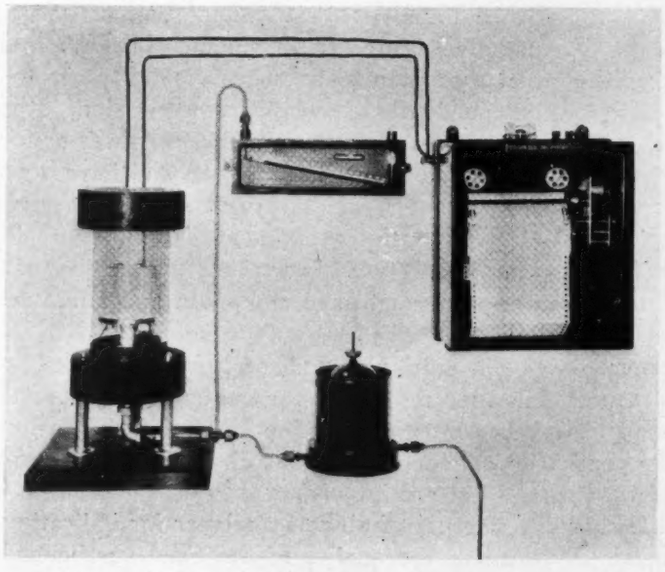


FIGURE 1
Brown Flame Analyzer with Recorder and suitable pressure regulating equipment.

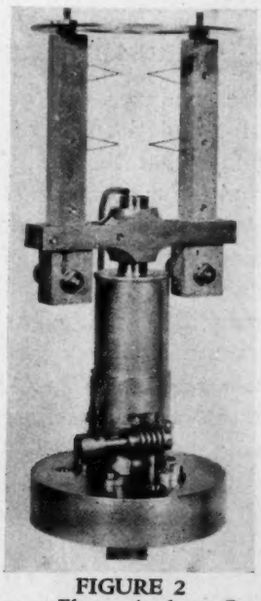


FIGURE 2
Brown Flame Analyzer Burner with Thermocouple in position.

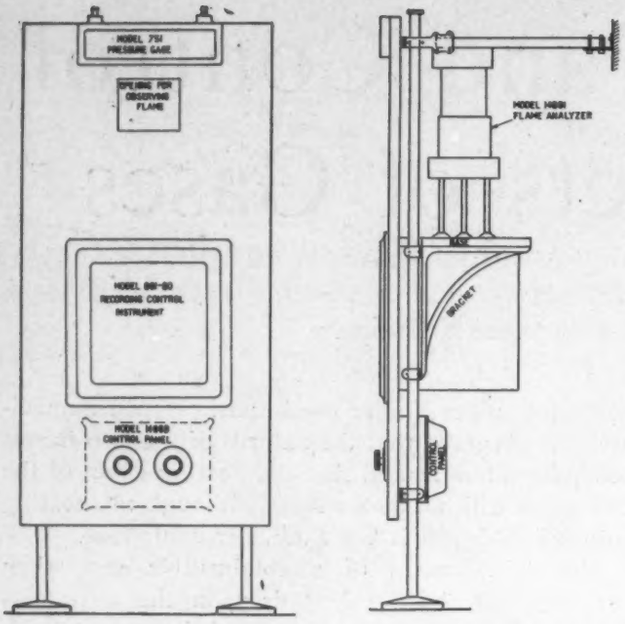


FIGURE 3

Typical panel mounting of Brown Flame Analyzer Installation for recording and automatically controlling gas heating value.

the mains very uniformly, but such instruments are not able to measure changes in rate of flame propagation, and hence cannot respond to such changes in the heating effect of the gas as due to this latter factor.

The Brown Flame Analyzer is a device recently developed for the important service of measuring and recording, and when desired, controlling the heating effect of gas.

VARIES HEATING VALUE

The flame analyzer can automatically vary the heating value and the rate of flame propagation in such a manner that the total heating effect is held constant, and the customer's flame effectiveness thus maintained unvarying. To do so, the changes which must be made in the heating value may be in the neighborhood of + or — 15 B.T.U., that is, if the gas were usually maintained at 550 B.T.U. by means of a calorimeter, the flame analyzer might vary the heating value from 535 to 565 B.T.U. in order to hold the flame characteristics uniform at all times. In this way, maximum effective utilization of the heating units in the gas are secured from its combustion.

The instrument briefly consists of a special burner mounted in a suitable shield and, with a number of thermocouples, so arranged as to be variously influenced by the flame. To the thermocouples are connected suitable instruments by means of which a record of the heating effect of the gas can be continuously obtained.

By supplying a recorder of the automatic control type and operating it in conjunction with suitable valves, the equipment can be made to automatically control the mixture, thus the consumer is always assured of a fuel that will burn in a given manner and the manufacturer is assured that he will get a minimum number of complaints about smoky pots (due to low rate of flame propagation) and about "low pressure" (the apparent effect of high rate of flame propagation).

It is naturally also important for still operators to know the quality of the fixed gas leaving the still. A recording flame analyzer will at all times indicate and record changes which may occur in the nature of the gas given off by the still.

For installation in refineries and at points where the fire risk is important, the analyzer can be installed in a fire-proof cabinet and mounted near the furnace or at any safe point. The readings of the instrument are transferred electrically and the recorder is mounted on a panel board at any convenient location desired. A recent application of the analyzer has been to indicate the effectiveness of absorption in a charcoal absorption natural gasoline plant.

The flame analyzer will indicate in how far the debutanizing process is accomplishing the end desired. The effect of butane on the flame is naturally to enrich it greatly and the flame analyzer will prove very helpful in measuring continuously the efficiency of the process.

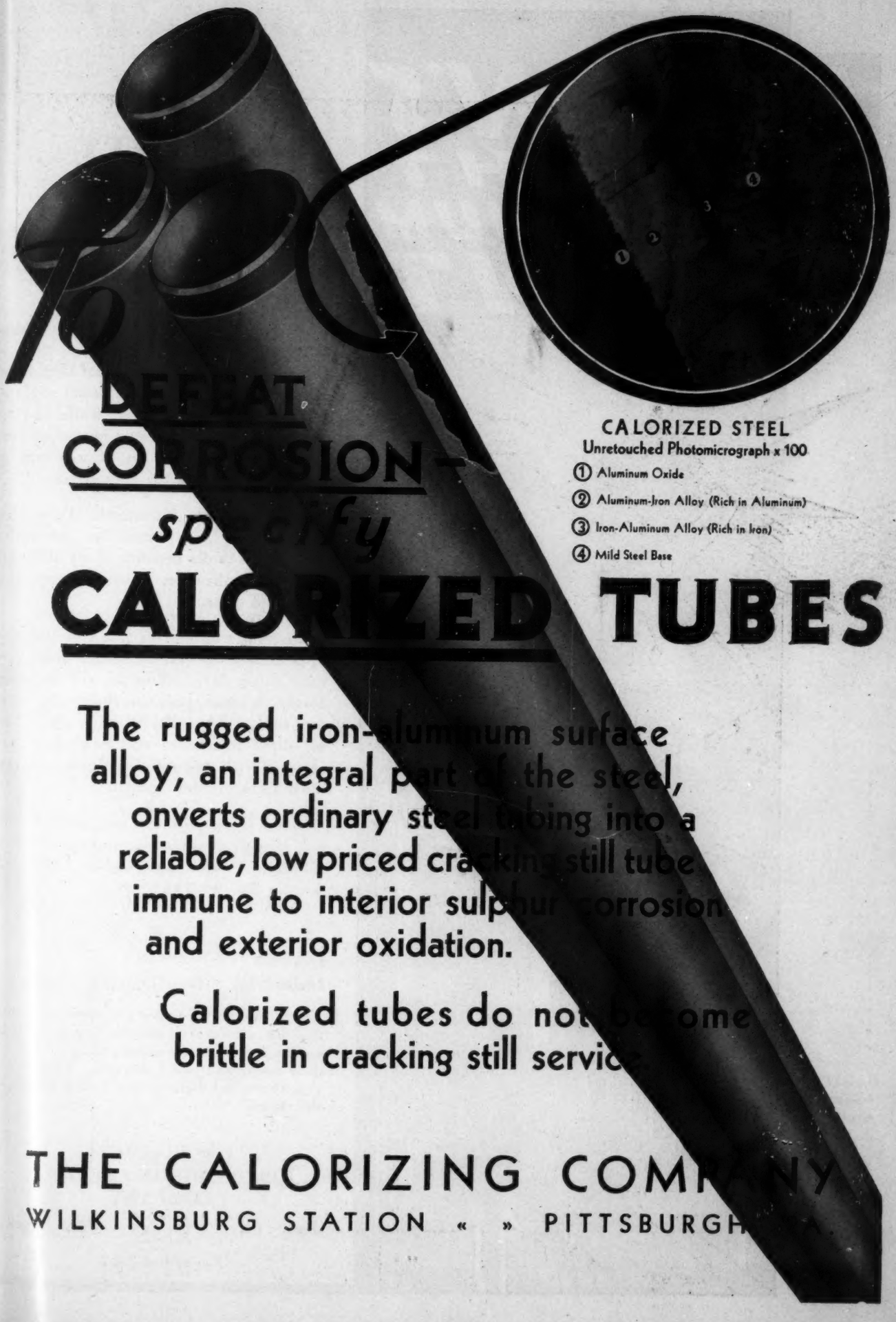
LIQUID GAS PLANTS

The establishment of small butane plants in many communities throughout the country is becoming very important. The service is of course invaluable to communities that cannot support a large gas manufacturing establishment. The automatic control for butane plants enables the plant to operate independently of any direct supervision. It is merely necessary to have a man drop in three or four times a week to see that all is well and have a safety device arranged so that an alarm will be given if the Brown control equipment should shut down the plant, as it will do in case the quality of the gas passes beyond fixed maximum and minimum limitations.

The efficiency of absorption is measured by placing an analyzer before the gas enters the plant and another afterwards. The savings that can be secured by catching inefficient absorption and correcting it quickly are important.

The use of a flame analyzer for indicating and recording the quality of the fixed gas being liberated from a cracking process should be of considerable interest. Experiments are now being conducted along this line.

The flame analyzer has proved very effective in measuring and controlling the quality of the gas mixture formed by blending refinery gases with blast furnace or water gas.



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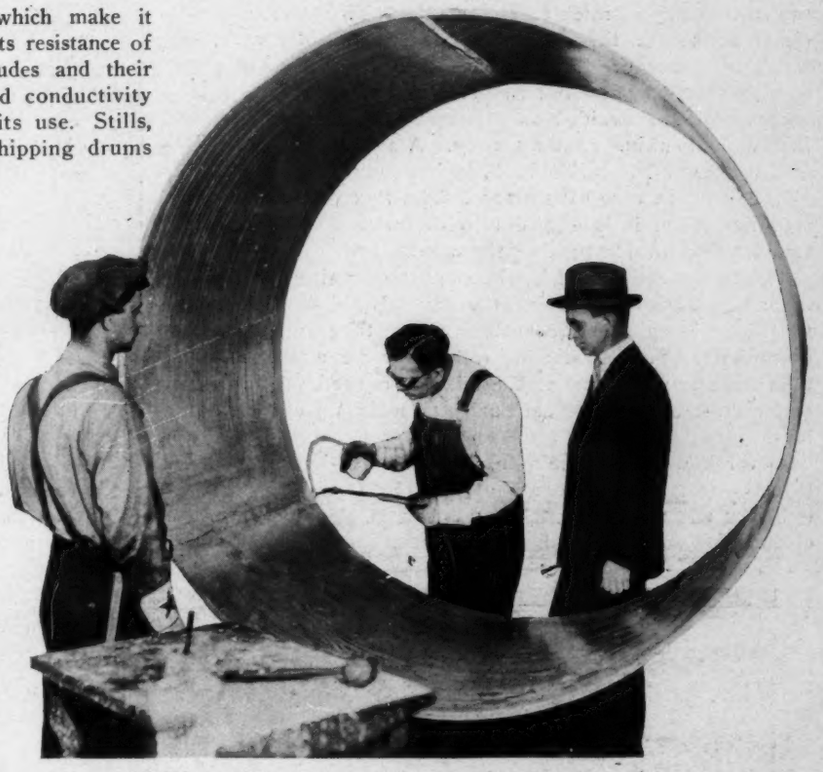
Welding Aluminum in the Oil Industry

By JOHN J. BOWMAN
Metallurgical division, Aluminum Research Laboratories, New Kensington, Pennsylvania

ALUMINUM has certain characteristics which make it a desirable metal for the oil industry. Its resistance of the corrosive action of high sulfur crudes and their gases, its light weight, high reflectivity and conductivity are the principal advantages which justify its use. Stills, heat exchangers, storage and flow tanks, shipping drums and truck tanks are now made from aluminum alloys.

Much of this equipment is built of standard products—sheet, tubing, castings. The ease with which aluminum can be fabricated, however, permits the use of intricate designs, and the fact that it can be welded easily and satisfactorily gives the designing engineer a much wider range in planning special equipment.

In the fabrication of oil equipment both riveting and welding play an important part. A riveted joint is usually used in connection with the strong aluminum alloys as a welded joint has a strength efficiency of only about 60 to 70 per cent. These alloys depend for their strength on heat treatment and the partial annealing from the heat of welding causes the reduced strengths. When this reduction in strength is not important, however, welding can be and is done. For equipment where gas or water-tight joints are important—especially when such equipment is made from commercial aluminum (2S) or the 1¼ per cent manganese alloy (3S) products—a welded assembly is generally used. Such joints, too, are of somewhat lighter weight than riveted ones.



Welding shell section of heavy gauge aluminum tank

All common types of joints can be made in aluminum but, naturally, certain of these are more easily made than others. For this reason it is common practice to use the straight butt weld instead of the lap weld which the steel arc welder prefers. The designs should be changed, too, so that welds are not made on corners or immediately adjacent to bends. Complicated welds should be avoided if possible and fittings should be kept separated so that the welds do not overlap.

Welding Practice

Nearly all of the plates used by the oil industry are ⅛ inch to ½ inch thick. In preparing the ⅛ inch metal for welding the common parctice is to notch the edges. These notches are made with a cold chisel and are usually 1/16 to ⅛ inch deep and about 3/16 inch apart. For material thicker than ⅛ inch it is advisable to bevel the edges to form a 90° vee. The bevel is not carried entirely through the sheet, but about a ⅛ inch lip is usually left. This lip is then notched as in the lighter sheet. On very heavy (over ½ inch) material it may be found advisable to bevel both sides and use a double vee type of preparation; this type of joint, however, requires welding from both sides. Although the lighter gauges of metal are not commonly used in the oil industry, it might be interesting to note that sheet from 1/16 to ⅛ inch thick is usually notched for welding, while the lighter gauges require no special preparation.

In setting up the work for welding, spacing of any kind is normally avoided. For small or light work it is advisable to have some type of jig to hold the edges in line; for large or heavy material, clamps should be used for this purpose. Long seams should be tack welded at uniform intervals of from about two inches on the lighter work to six inches or eight inches on the heavy plate. All tack welds should be "burned in" well and, when widely separated, should be several inches in length.

Aluminum and its alloys are coated with a film of oxide, which forms as soon as the metal is exposed to air. This formation is especially rapid at high temperatures and unless this film is removed during welding the molten metal will not coalesce. For this reason the flux-method of welding is now almost universally used in welding sheet aluminum. In this method the oxide film is removed from

the weld by a molten flux, the flux, containing oxide, remaining as a surface "slag" when welding is complete.

A suitable flux for use in welding aluminum must melt at a temperature slightly less than that of aluminum and must be stable at its melting point. It should not deteriorate with age nor be too deliquescent. In the molten state it must be able to remove the aluminum oxide readily and quickly and this action must be sufficient to take care of all oxide, which may be present. The molten flux, containing the oxide, must have a specific gravity less than that of molten aluminum. This difference should be great enough to cause the flux and oxide to come to the surface of the weld quickly and completely.

Preparing the Flux

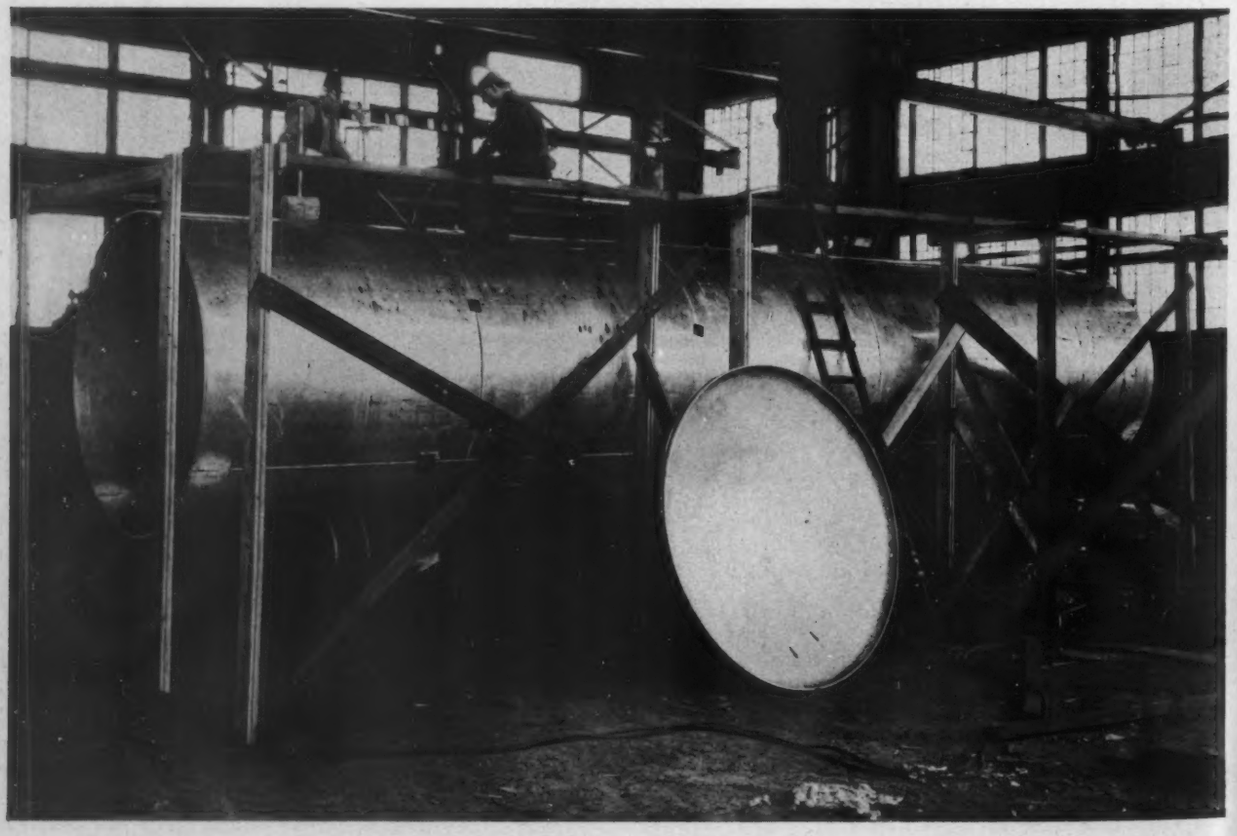
In preparing the flux for use it is mixed with water to the consistency of thick cream or paint. This paste is then either painted on the seam or applied to the filler wire; as the latter procedure is better, it will be found a good plan to keep the flux paste in an aluminum, brass, or glass tube. Iron should be avoided as this metal is attacked by the flux with resulting contamination. A tube about 1½ inch in diameter and 15 inches to 18 inches long, plugged at one end, will prove very satisfactory. The flux which clings to the wire when it is dipped into the tube will usually be found sufficient for making the weld.

The flux paste should be thoroughly stirred every morning and occasionally during the day. If this is not done the flux will cake in the bottom of the tube and must be discarded. Fresh flux and water may be added to the tube from time to time as the mixture is used. Additional water must be added occasionally to make up evaporation losses.

In torch welding aluminum, both the oxy-hydrogen and the oxy-acetylene flame are used. The former, however, is better when it will supply enough heat, as it produces a cleaner and sounder weld. For material more than ⅜ inch thick, however, the oxy-hydrogen flame will not supply sufficient heat so the oxy-acetylene flame must be used.

Welded aluminum coil assembly

Regardless of which gas is used the torch should be adjusted to produce a neutral flame since this flame has the highest temperature and is the most economical. Aluminum does not absorb carbon at welding temperature, so a



Shell of large aluminum tank assembled for welding, showing use of clamps for alignment

Personal

Mr. S. B. Daugherty

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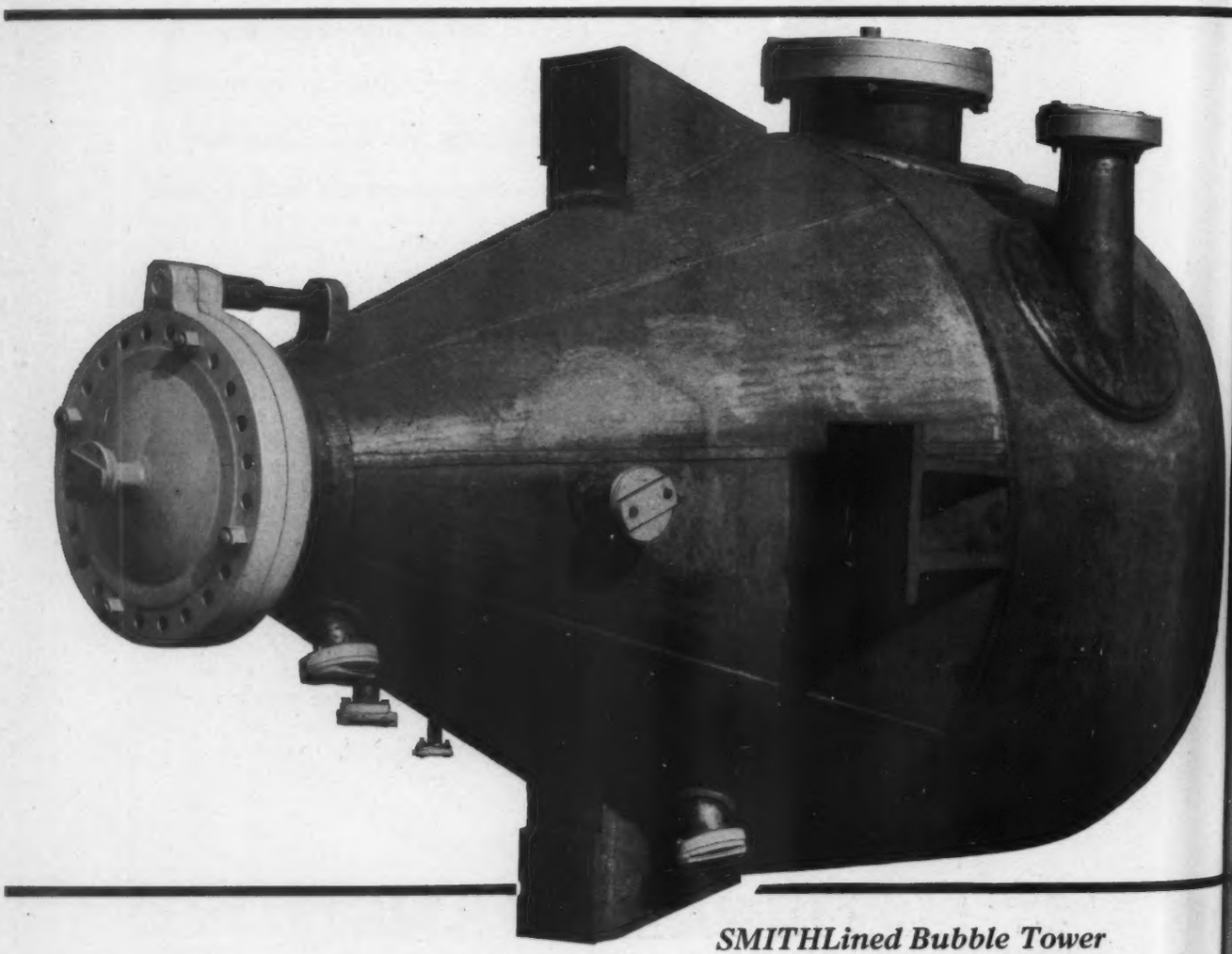

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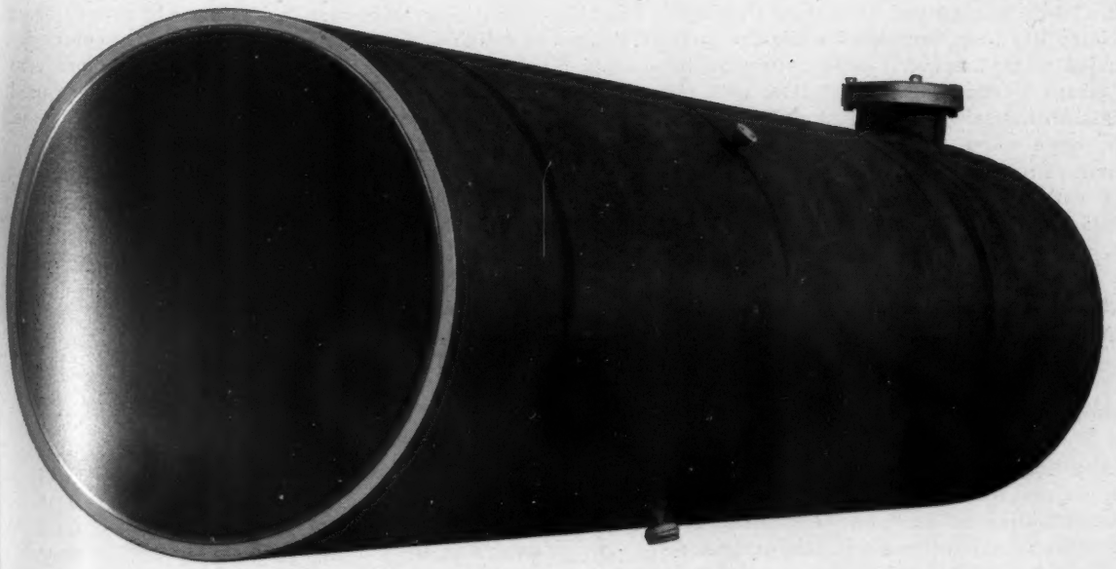

CORROSION-PROOF

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slightly carbonizing flame is permissible. An excessively carbonizing flame will deposit a large amount of carbon on the weld, however, with the result that the action of the flux is retarded and welding speed reduced. The oxidizing flame should be avoided for reasons which are quite evident.

In making the weld the torch is held at an angle of about 30° with the sheet and with the tip about an inch from the puddle. This helps to prevent burning holes in the work due to local overheating and, at the same time, preheats the metal ahead of the puddle. The flame should be directed so that it heats both sheets uniformly and melts the sheets and filler rod at the same time. The end of the filler rod must be kept in the flame as the heat in the puddle is not sufficient to melt the wire. As the welding progresses it is necessary to increase the welding speed since the temperature of the sheet gradually rises.

Aluminum liners for steel shipping drums. Note how heads are flanged to keep weld away from corner

Aluminum Expands

It is a well-known fact that aluminum expands when heated and that this expansion is about twice that of steel. Theoretically, the material will contract as much on cooling as it has expanded on heating and the net result should be zero. The welding has been completed while the metal was in the expanded state, however, and a return to the original size and shape is sometimes impossible, with the result that the finished assembly may be slightly buckled. The distrotion is, quite often, more or less symmetrical and not detrimental. In some cases, however, the buckles must be removed and, when this is necessary, they can easily be hammered out.

Since aluminum has a high rate of heat conductivity, the heat of the torch flame is rapidly drained from the vicinity of the weld. This is particularly noticeable in heavy material and will often require a much larger torch tip than would be expected. Table I offers a guide for selecting the tip to be used on different thicknesses of metal. These tip sizes are not offered as an inflexible rule, and the table should not be considered in that light. The sizes given are the averages of the tips actually used by a rather large group of welders. It will often be found an economic advantage to use a preheating torch, too, since this speeds up the work and reduces the volume of welding gas required.

TABLE I

Metal thickness B. & S. Gauge	Size of orifice in tip (inches)	Oxygen pressure (lb. sq. inch)	Hydrogen pressure (lb. sq. in.)
Oxy-hydrogen			
20 gauge to 18 gauge	0.062	1	2
16 gauge to 14 gauge	0.078	1	2
12 gauge to 10 gauge	0.093	2	4
⅛ inch to ¼ inch	0.125	8	12
5/16 inch to ⅜ inch	0.109	4	8
Oxy-acetylene			
24 gauge to 18 gauge	0.031	1	2
16 gauge to 14 gauge	0.042	1	2
12 gauge to 10 gauge	0.051	8	6
⅛ inch to 3/16 inch	0.062	12	8
¼ inch	0.074	20	8
5/16 inch	0.084	25	8
⅜ inch to ⅝ inch	0.095	25	8

The proper selection of welding wire (or filler rod) is of major importance in securing consistently reliable joints. Most work on the light gauges of 2S or 3S is done with a commercially pure aluminum (2S) wire. This wire is of substantially the same composition as the sheets and, therefore, has the same general properties. (The 1¼ per cent manganese in the 3S has little effect on its welding properties.) It is sometimes found, though, that the base metal is not free to contract immediately after welding and severe strains are thrown in the weld while it is still hot. These stresses are especially severe in heavy material and, in the cases where a weld is made near a bend, may cause cracked welds. In addition, the heat treated, strong alloys are somewhat hot short and, therefore, subject to cracks. To avoid this trouble a silicon alloy filler rod is commonly used.

These alloys have a small solidification shrinkage, a low melting point, good hot strength, and are quite fluid when molten. These characteristics enable the weld to absorb contraction strains without cracking. The action of the weld metal can be compared to that of a gate in a casting as the low melting point results in the weld proper being the last to solidify. At the present time, the most commonly used alloy of this group is that containing five per cent silicon and 95 per cent aluminum. This alloy has been used exclusively on the strong alloys with very great success.

Wire Size Varies

The size of wire used for various work will often vary with the welder. A ⅛-inch diameter will usually be found suitable for metal up to ⅛-inch thickness while a 3/16-inch wire is commonly used on heavier material. The accompanying Table (II) can be used as a guide, but is not offered as a rule.

TABLE II

Metal thickness B. & S. gauge	Metal thickness (inches)	Wire diameter (inches)
Up to 18	Up to — 0.040	0.080
18 — 16	0.040 — 0.051	0.092
16 — 14	0.051 — 0.064	0.104
14 — 12	0.064 — 0.081	0.116
12 — 10	0.081 — 0.102	0.128
10 — 8	0.102 — 0.128	0.144
8 — 6	0.128 — 0.162	0.160
6 — 4	0.162 — 0.204	0.176
4 — 2	0.204 — 0.258	0.192
2 — 00	0.258 — 0.365	0.212

In making the welds in rather heavy (1¼-inch) metal it is common practice to make the weld in two layers and to work from only one side of the sheet. The first layer of the weld is burned in thoroughly to insure good penetration and the vee is only about half filled. Going over the weld the second time permits completion of the weld and the building of a suitable reinforcing bead. A little care in applying this second layer is necessary when working from the edge of a sheet. In this case it is advisable to start at a point about six inches from the end and weld back toward the normal starting point before starting down the seam. If welding is begun at the edge and carried straight through, the weld will sometimes crack directly behind the welder and this crack will usually follow

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It isn't a question of the price of crude, it's what kind of gasoline you can make and what it costs to make it

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Dubbs cracking makes premium gasoline from fuel oil or

any charging stock—from oils cheaper than the cheapest crude

Cheapest charging stock—Lowest operating cost—Best gasoline

That's a combination hard to equal and impossible to beat

That's the way to profits

Dubbs cracking is always the answer

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have been used for steam boilers for 25 years and are now being used by leading oil companies for indicating oil levels in tanks, towers, stills, etc.

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him down the seam. The first layer of the weld holds the metal rigid and the contraction following the application of the second layer, having no other outlet, produces the crack. In a circular seam it is advisable to start the weld near a "tack" so that the tack-weld will absorb the contraction strains. These precautions also apply to the welding of all gauges of the heat treated strong alloys. Welding on these alloys should never be started at the edge of the sheet as their hot-shortness will almost invariably cause cracked welds.

When welding has been completed the flux should be carefully washed from the weld. The flux is designed to remove the aluminum oxide and, since the oxide is the more resistant to attack, it is natural that the flux will attack the metal. If the flux is not completely removed, there is danger of some corrosion after the equipment has been placed in service. Furthermore flux remaining on the seam will cause paint to blister and peel off. Warm water and the vigorous application of a scrubbing brush will usually prove sufficient while a steam jet, closely followed by a stream of water, is very good. Soaking the welded articles in warm water or a three to five per cent nitric or sulfuric acid solution is recommended, when possible. Of coure, the acid bath should be followed by a rinse in water.

After the flux has been removed the weld can be finished by grinding or by chipping and hammering, in case a smooth surface is desired. Many welds are left "as welded", but when a finish is desired, chipping and hammering is the common practice.

Welded 2S or 3S alloy structures, except those made from fully annealed sheet, when viewed under the microscope, normally show three distinct areas. The weld proper is, of course, in the cast condition since the metal has been entirely molten. An area where partial annealing has occurred is found on either side of the weld and beyond this zone the sheet is unaffected. Usually the weakest point in such a structure occurs about ½-inch to one-inch from the edge of the weld, especially if the reinforcing bead is of a normal height. When the structure is being made from annealed sheet, however, the two zones outside the weld merge and there is no definite point of weakness unless it be that point where the weld and sheet join and an abrupt change in thickness results. Welded structures of annealed material will develop approximately 100 per cent strength efficiency but, due to the partially annealed zone, welds on hard rolled sheet can not be expected to develop such a high value.

Many of the fittings used on tanks are castings and are usually 43 alloy (five per cent Si, 95 per cent A1). When welding these castings to tanks, five per cent silicon wire should be used. The technique for welding castings is substantially the same as that used on sheet, but care must sometimes be exercised on castings to secure more uniform expansion and, on large and intricate castings, total preheating is often required. This preheating should never be carrier above 800° F. When pyrometric control is not available, a good test is to draw a pine stick across the metal. When the stick leaves a char-mark the preheating temperature has been reached.

Practically all fusion welding at the present time is being done with the torch, but it might be well to mention that the arc welding of aluminum is being developed. At this time, however, the process is just emerging from the experimental stage and its possibilities are entirely a matter of conjecture. The operating technique is only partly established and the properties of the weld are not fully determined. The indications are, however, that this type of weld is slightly porous but will develop a higher strength efficiency than a torch weld.

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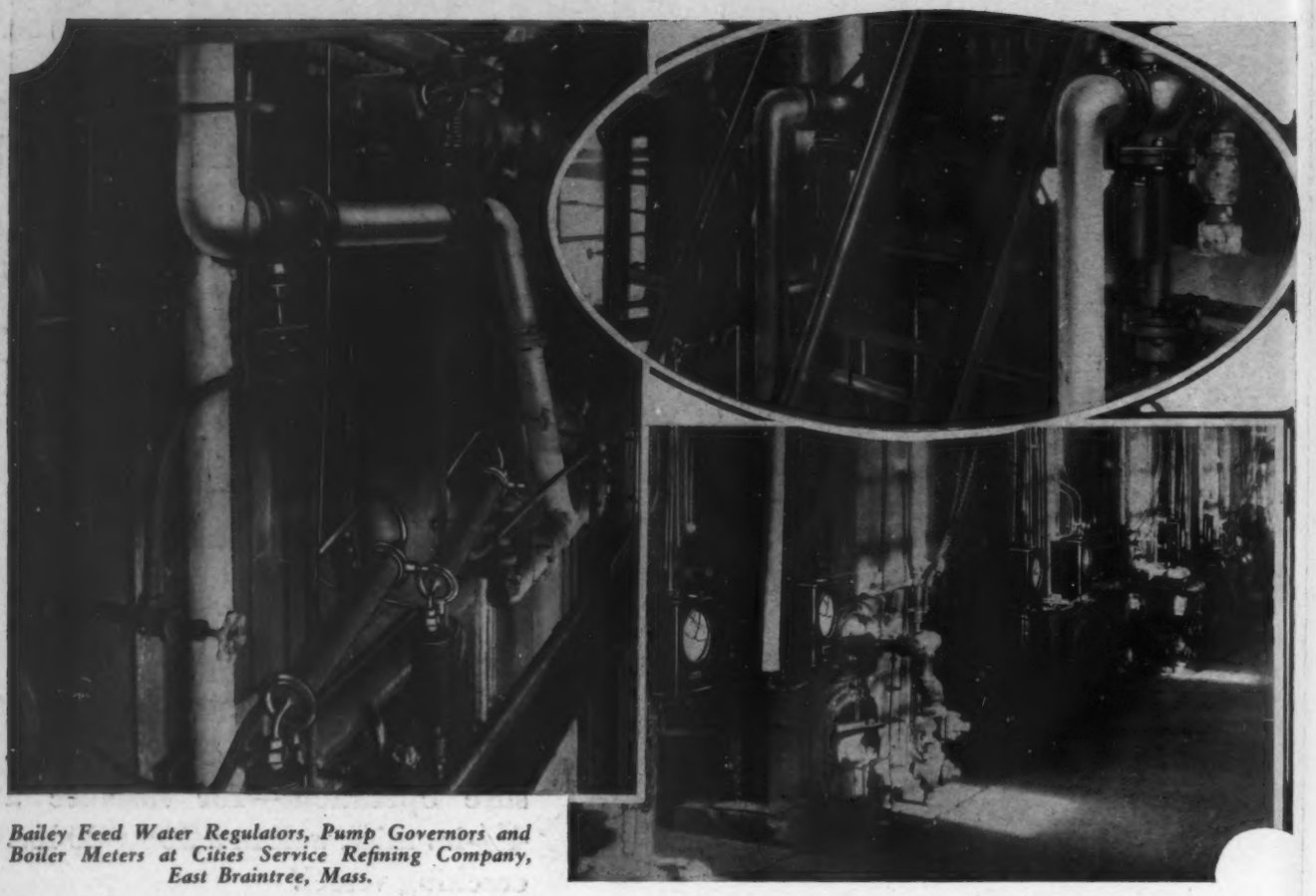

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Every plant engineer is vitally interested in increasing the economy and capacity of his plant with the least expenditure. The first step is to locate and accurately determine the magnitude of the losses so that they may be reduced to a minimum, thereby improving final results.

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In the Boiler Room, the operators will find that Bailey Boiler Meters, Multi-Pointer Gages and Feed Water Regulators eliminate costly guess work. With the aid of this equipment, boiler capacity and efficiency can be materially increased.

You will find many places throughout the refinery where Bailey Meter Equipment will improve operation and result in savings. Interesting booklets fully describing any of the Bailey Meter Products shown on the opposite page will be sent free upon request.

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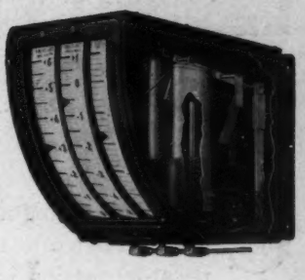
Bailey Boiler Meter

Serving as a combustion guide and flow meter, the Boiler Meter enables the operator to obtain the desired capacity with best efficiency at all times.

The meter indicates, records and integrates Steam Flow from the boiler, records Air Flow supplied for combustion and records Flue Gas Temperature. It is only necessary for the operator to keep the Steam Flow and Air Flow pens together to be sure that maximum efficiency is being obtained regardless of the load. Completely described in bulletin No. 43.

Bailey Multi-Pointer Gage



The Multi-Pointer Gage is used to indicate secondary factors in connection with boiler operation such as draft, pressure, temperature, rate of flow, and stoker speed.

This gage can be made with any number of pointers from 1 to 12. The pointers have a travel of 10-inches over plainly marked internally illuminated scales which are readable from a considerable distance. It can be furnished in the wall mounting type of case, the semi-flush or the full flush panel mounting type of case, as desired. Fully described in bulletin No. 162.

Bailey Fluid Meter
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Because of its accuracy and dependability, this Fluid Meter has been accepted as the standard in many plants.

It is recommended for the measurement of steam, water and other liquids. Records are made on 12-inch uniformly graduated charts reading in the desired terms. Auxiliary recorders of temperature and pressure may be installed in this meter if desired to give a record of these factors on the same chart with the rate of flow. Full details given in bulletin No. 37.

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The Electrically Operated Fluid Meter is particularly desirable where it is advantageous to locate the instruments at a considerable distance from the pipe line in which the flow is being measured.

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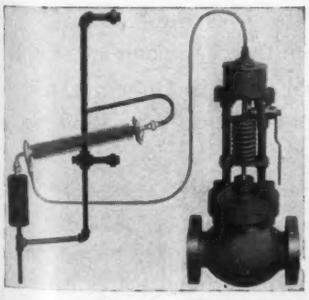

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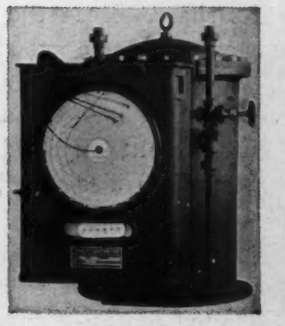

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EDITORIALS

CERTAIN unmistakable signs are at hand to give evidence to the fact that the end of business depression is near.

Several months back amateur traders at the brokerage houses went into the bear camp. This was accepted then as proof that a bull market was in the making. The reasoning was based on long observation to the effect that the amateur trader turns to either side of the market after that course of prices has run its distance.

The stock market is still a sore subject but it is a barometer that is not to be ignored. The course of prices on the stock exchange reflects business conditions several months in advance. The rise in security prices in January was an omen of good sort for commodity prices for the end of this year.

Another bit of evidence of the coming turn in business is the wave of dividend reductions and omissions. Just as the appearance of extra dividends and increased dividends presages the end of abnormal earnings on the high side, so the appearance of dividends passed and dividends reduced are evidence of the end of subnormal earnings on the low side.

The first quarter of 1931 witnessed an avalanche of dividend reductions. The petroleum industry had its share. Even the corporations whose dividend payments were not altered published balance sheets which revealed earnings far below those of 1930. The petroleum industry as well as other industries still has a welter of dividend changes to face, but these have been discounted long ago.

Big scale buying of basic commodities by the larger corporation is another evidence of the low point in prices. Several of the largest concerns in the United States—General Motors being one—recently have bought metals in quantity to supply needs for the remainder of the year. These moves were not made until buyers were convinced they were buying at the lowest figures they would see.

Commodity prices are now below the cost of the commodity in numerous instances. This situation is a sure indication of an upturn, because no industry can long sell its products for less money than they have cost. The practice shortly eliminates sufficient of the sellers to throw the price back on the profit side.

The petroleum industry is in that position. Gasoline at refining points can not long sell under four cents a gallon. Such figures will not provide raw material and supply labor and plant expense. Neither can gasoline long sell at less than 10 cents at service stations. The figure will not long maintain the equipment and service essential to the selling.

It is regrettable that correction must come through the elimination of those who follow the trend. But only those with sufficient surplus to withstand the period of below-cost selling can weather the storm of a commodity going to the consumer at a price less than its cost.

There is no method of determining the day business conditions start their upswing. But there are evidences which must not be ignored; and these now point to an early day of business conditions changed for the better.

EVIDENTLY that part of the refining industry not maintained at seaboard in the United States can confine its outlet to the United States. Russia may furnish the gasoline for continental Europe in 1931 and possibly for other years. Tariff retaliation has shut the Canadian market door to the American refiner.

These facts were offered at the annual meeting of the Western Petroleum Refiners Association in March. There will be shipments to the Orient and possibly some shipments to Europe, but the inland refiners will not get any benefit from these.

Fortunately this home market is the best in the world. Instead of bemoaning the activity of the Soviet and the throwback of tariff, refiners of the inland states should accept what they have as the best available and set about to supply its demands in the best manner possible.

Just as the depression year 1930 brought a gasoline consumption increase over the banner year 1929, it is possible, although not assured, that 1931 will find more gasoline consumed in the United States than was consumed in 1930.

The petroleum industry is in no worse plight than some other American industries. The whole trouble is that men are inclined to consider record-breaking as the only evidence of progress. In that light, 1930 was a wretched year because it brought a gasoline consumption increase of only five per cent, against former increase of 10 per cent.

Some other industries would be staggered by a five per cent increase in the consumption of their products, even in banner years.

Development in the Carbon Black Industry

[PART II]

By GEORGE REID
Associate Editor

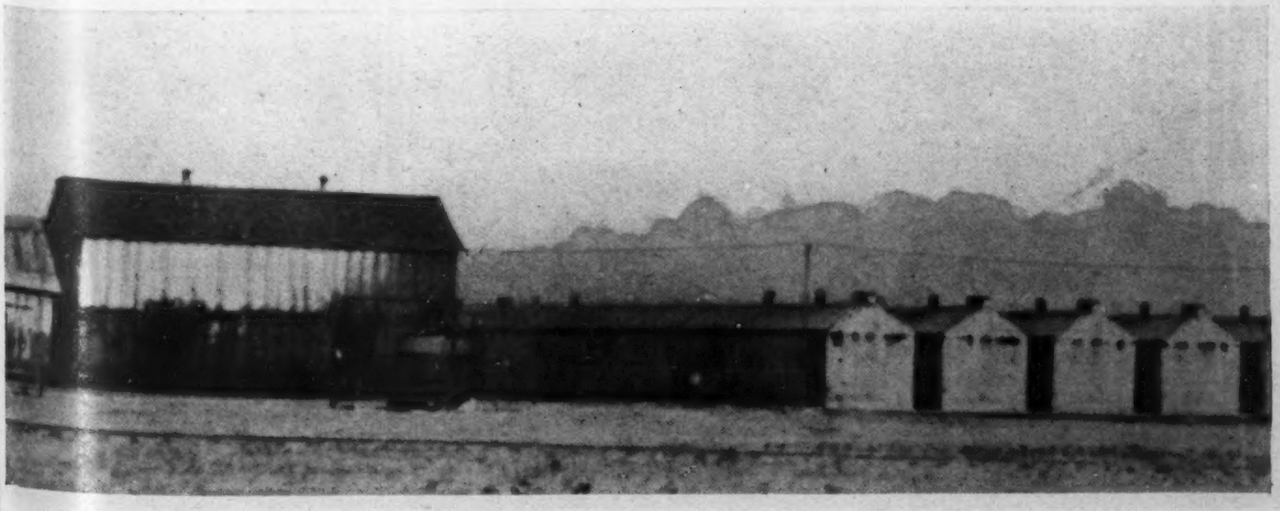
MUCH progress has been made in carbon black manufacture during the past 10 years and to the end that recovery of black from the gas burned has increased from a general average yield of 0.8 to 0.9 pounds to approximately 1.4 to 1.5 pounds per 1000 cubic feet of gas burned. In addition to improvement in the principal process employed there has been a concurrent reduction of operating losses and accompanied by better methods of bolting, screening, and packing, all of which have contributed to the present improved economy of manufacture.

Eighty-eight to 90 per cent of all carbon black produced is made through the use of the channel process. The remaining production comes through the employment of such processes as the disc, Lewis, roller, Gastex, Thermtomic, and "special" systems in various stages of development.

The channel process type of plant of standard type consists of about 32 to 34 burner buildings. These buildings are constructed of 1¼ by 1¼-inch angle iron, which in many cases are welded in their erection, thus effecting marked savings in the cost of construction. They range in length from 116 to 140 feet, are about 10 feet wide, and nine feet in height. They are covered with 24 gauge V crimp painted flat iron. The sides of such buildings are slotted two inches by 12 inches at the base near the ground at intervals of four to six feet on each side for purposes of regulating the amount of air admitted. They are arranged in parallel rows four feet apart and on each side of a 16-foot alleyway which accommodates the driving machinery and conveyor equipment for transporting the black from the "hot" houses to the packing bins. There is a tendency toward the use of the larger buildings of 140 feet length and 10 to 12 channels wide. The roof of each building is left with an opening at each end from four to six feet in size, which serve as smoke outlets.

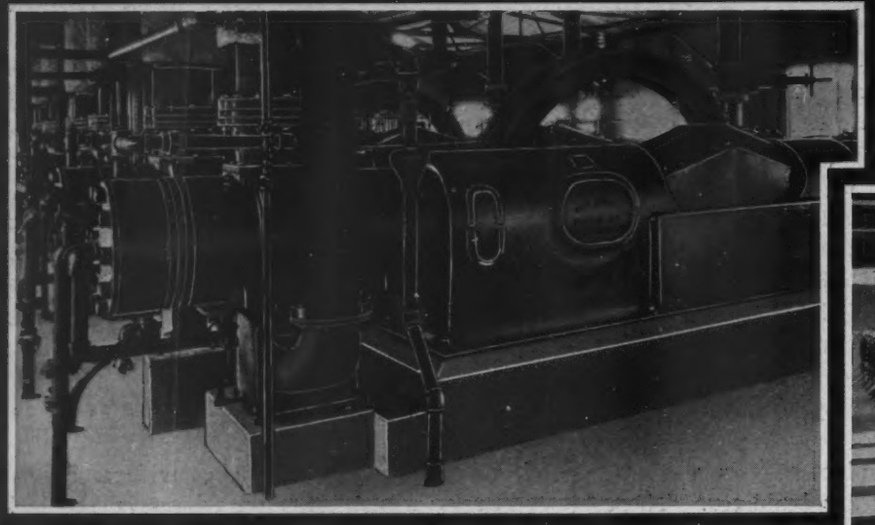
CHANNEL AND BURNER EQUIPMENT

The channels are eight inches wide and are bolted together by means of cross channels six inches in width which are at right angles to the "black" collecting channels extending across a row of eight channels placed at intervals of 1⅜ inches. This section of collecting channel is 116 to 140 feet in length, and is

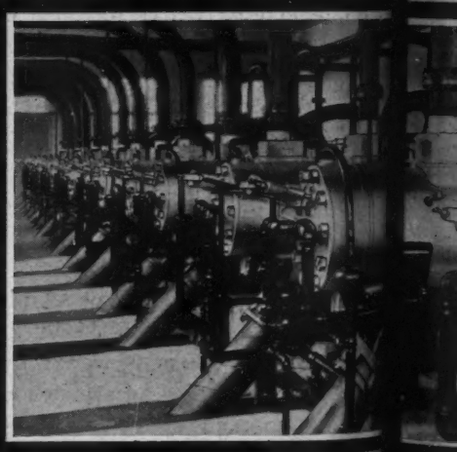


CLARK

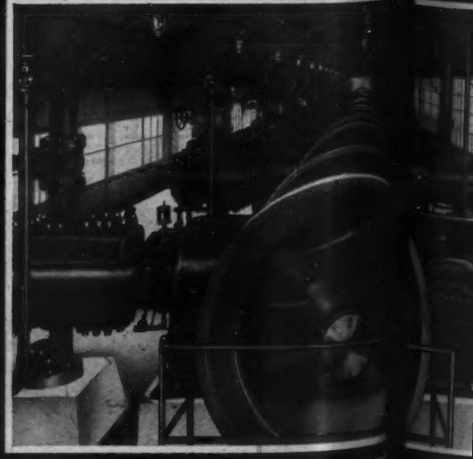
Efficiently and



(Left) 200 H. P. Super 2s, with new inverted exhaust, at a Kansas refinery.

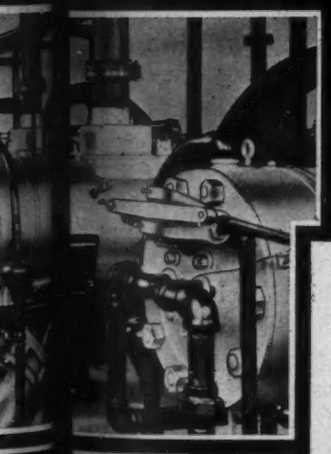


(Above) 400 H. P. Double Acting CLARK Super 2s in a Louisiana Vapor Recovery Plant.

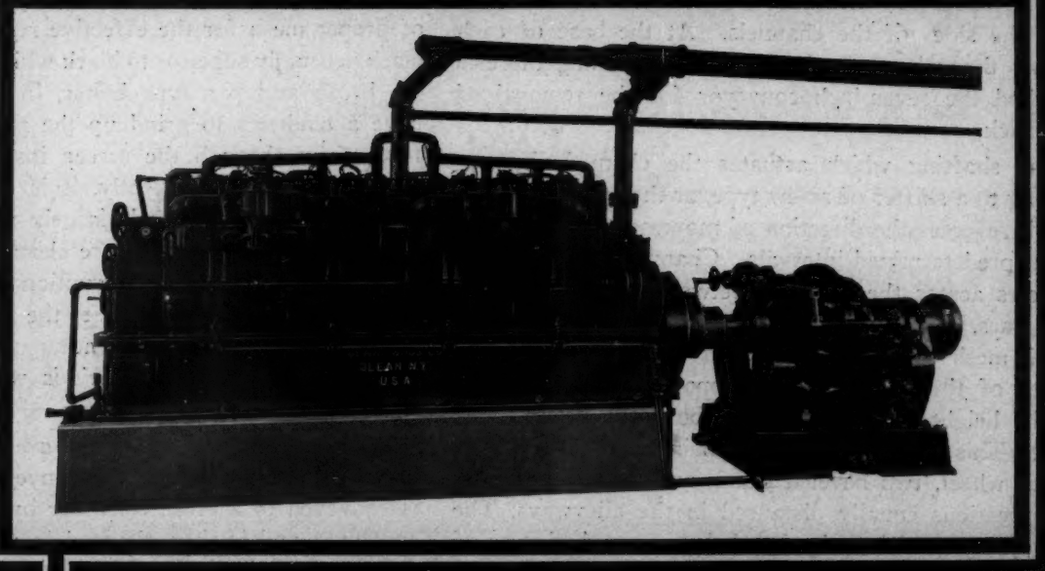


(Right) 100 H. P. Clarks at Rising Star, Texas

LE Perform Economically in Refine[illegible] Service



(Left) 200 H. P. CLARK Super 2s in plant at Port Arthur, Texas



(Above) CLARK 8-Cylinder Vertical Gas Engine — an ideal unit for hot oil pump drive or for driving gasoline line pump.

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mounted on two 6½-pound rails by means of 10-inch flanged wheels spaced along each side of the channel section. The rails, in turn, are supported by one-inch pipe which rests on the four-inch feeder line running the length of the burner building.

The pipe supports are spaced four feet apart and the gas lines feeding gas to the burners are connected to the four-inch feeder line by one-inch pipe alternating between the pipe supports. The headers across the burner section being of one-inch pipe also, then each burner pipe, which is drilled with a ⅜-inch tapering hole, spaced from three to 4½ inches apart, is connected to the manifold by ⅜-inch right and left hand nipple.

This practice places a burner pipe containing from 10 to 13 tips, according to the spacing, in the center and parallel to the bottom side of the channel The burner pipe runs parallel to the length of the building underneath the channels, and is located from 2½ to three inches below the bottom of the channels.

The lava burner tips are taper with a slot in the top which ranges from .021 inches for a tip burning 10 cubic feet of gas, to .034 inches for a "20-foot tip." Although most plants use the 10-foot tips, there has been a tendency in recent years to use 20-foot tips, for which better results are claimed. These tips are placed in the burner pipe by tapping in the tapered hole drilled in this one-inch pipe and the tips are coated with white lead to prevent leakage.

The hoppers which contain fixed scrapers at the top and in contact with the channels are placed every four feet and running across and underneath the channels. Side scrapers are also provided which are in contact with the sides of the channels. At the base of each hopper throughout the length of the building there is attached the seven-inch conveyor for the removal of the black.

The shafting which actuates the channels is connecting to a shifter of screw type, or the spur rack type, which reverses the direction of movement of the channel at predetermined intervals. Channels are connected in pairs across the alleyway between the buildings by pull bars, and bolted to these bars are spur racks which mesh with gears on the drive shaft running the length of the alleyway and supported about six feet, or the height of the channels, above the ground surface. This drive shaft (3 15/16 inches) is driven by a bull wheel, two beveled gears, and a worm gear, in two locations equally distanced in the alleyways. The conveyors are driven by beveled gears and pinions of the expansion type running the length of the alleyway and on each side and connecting with each house.

PULVERIZING AND CONVEYING

In THE OIL WEEKLY, a sister publication of this magazine, H. L. Kauffman, writing in the August 9, 1929, issue, "Progress in Carbon Black Manufacture," attributes much of the improvement in this industry to more efficient tip design, more intelligence in operation through the application of results gained by research, the concentration of production in larger units, and the marked improvement in so-called auxiliary equipment. In regard to modern pulverizers for elimination of grit, he writes, "One carbon black manufacturer has been able to add materially to his production by the use of a special pulverizer. This machine ordinarily requires only three horsepower to handle approximately 7000 pounds of black each 24 hours and now does the work that formerly required four pan-type bolters of the rotating type, the carbon black being put through the screen in these pan bolters by means of wire, fibre, or bristle brushes. This pulverizer has done away with the human element required with the use of the pan bolter to clean them every so many hours. The company using this pulverizer found that it has added materially to the net recovery of production by the elimination of waste black which was lost through cleaning the old type bolters and through leaks. With this pulverizer the entire system is practically dust proof."

Conveying carbon black pneumatically from the time it enters the packing house—to which it is transferred by mechanical conveyor screws—until it reaches the bin immediately over the packer, has been another important development in the manufacturing systems. Such a method of conveying is employed in connection with an air separator for removing grit. Certain advantages lie in the fact that elevators and other devices are eliminated, all of which require constant repair, and a product is obtained which is far more free from grit than is possible with the ordinary brush bolter. Pneumatic air bolters are necessarily equipped with screens of proper mesh for the effective removal of grit. Such black is usually superior to black which is bolted through the brush and pan type bolter, in which the brushes have a tendency to grind up the particles of grit and force them through the screen instead of eliminating the impurities, consequently, it is said, the efficiency of the pan bolter depends largely upon the frequency of cleaning. Such bolters are cleaned by removing the pans, which means an interruption in the process, and such work is very obnoxious to the workmen. Some of the pneumatic bolters are continuous in operation, having run for four-month periods without opening for cleaning.

Where pneumatic conveyors are not employed carbon black is handled in the conventional manner. It is conveyed to a cross conveyor by the main alleyway conveyor, and is then elevated in a bucket elevator to a preliminary bin, from which it is fed by gravity to a pulverizer or bolter, which pulverizes all of the course particles contained in the black to 40 mesh or smaller. This mill consists of high speed revolving arms, or blades, which force the carbon black through a steel screen perforated with small holes—1/64-inch or less. The black is then elevated to the storage bins which are closed galvanized iron tanks 12 by 26 feet at the tip,

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tapering down to 2½ by 26 feet at the bottom. Along the bottom of these bins there are six carbon black packers attached which are of the flour packer type and mechanically driven. This procedure is varied by some companies who have different size storage bins, different types of agitation and air separation of the coarser particles of the black.

CLEANER INSTALLATIONS

New methods for collecting carbon from flue gasses has, in the experience of some operators, produced a higher ultimate recovery. Several companies are using fans and oil washers for exhausting the carbon from the houses and then removing the carbon from the gasses. In regard to this Kaufman quotes an equipment manufacturer as stating "Off hand we could not say if it really pays to install the washers for collecting the carbon unless there was some particular industry that can use the carbon with a small amount of oil in it, which of course, is what you have after the carbon has come from the washer and has gone through the filter. However, one thing we will say is that with a system of fans exhausting from the top part of the burner houses, you can concentrate the smoke and make a much cleaner installation."

It is well worth mentioning that a number of carbon black manufacturers had installed vacuum sweeping methods that are used in a number of places for collecting carbon black from floors, walls, around machinery, and the like, as a means of improving working conditions.

Most plants use a separate power source for each unit, that is, a gas engine or gas pressure driven steam engine located near the packing house, driving the whole unit through the shafts, chains, gears and belts. However, the modern plants such as those recently erected in the Texas Panhandle are driven by electric motors, with a separate motor being used for each part of the operation. Some companies use a central power station to operate two units, but the usual practice consists of providing each with a prime unit. A unit consists of a packing house, bolter room, and from 20 to 50 burner buildings.

Where gas pressure is sufficiently high, a D slide valve engine operated by gas pressure is used, the gas being preheated to prevent freezing in the cylinders. The discharge from these engines passes through a drip which eliminates the pulsation of the gas, which in turn, is transported to the main gas header and burned in the burner buildings. Where low gas pressure is encountered internal combustion engines are used, and these two are run on natural gas.

PACKING AND SHIPPING

As it comes from the burner building carbon black is very bulky and without proper handling only three or four pounds could be placed in the standard bag. However, through special treatment much of the air is driven out so that the standard package with which users are familiar contains 12½ pounds net, and measures 21 inches long, 11 inches wide and eight inches thick.

The product is also packed in medium compressed form. For this manner of packing the standard bag is subject to mechanical pressure which on account of the nature of the black, must be applied slowly so as to allow time for the air to be driven out from the tied end of the bag without injuring the container. The bag is pressed down in one dimension reducing the thickness to five inches. The volume is reduced 40 per cent from that of regular uncompressed black. In some cases double compression is applied, in which medium compressed bags are handled in a separate press where pressure is applied to another dimension to reduce the width of the bag to six inches, so that the finished package is still 21 inches long, but only six inches wide and six inches thick. This gives an extremely compact bag of black, in some cases then known as blocks or briquettes. When put on the mill, although readily friable when properly handled, the black tends to hold together in small pieces, thereby practically eliminating the tendency toward being blown into the air as dust.

The product is shipped in carload lots. The general method is to take the original 12½ pounds bags, either compressed or uncompressed, and in order to insure safe delivery an overslip is used thereby giving a double container for each package. If these bags are made of a heavy rope paper, they are safer and more easily handled and simplify storage problems since their weight and size permit piling them in tiers of considerable height. Except for certain special points a regular carload consists of 1600 bags totalling 20,000 pounds net to the car.

For less than carload shipments, or for export business the black is put up in a standard wooden case containing 12 bags of uncompressed carbon black, 18 bags of medium compressed black, or 25 bags of heavy compressed black. The medium weights are respectively, 150 pounds net, 225 pounds net, and 312½ pounds net.

OTHER PROCESSES

General Atlas Chemical Company (Cities Service group) has been operating a smokeless carbon black plant at Pampa, Texas, treating gas with a relatively high sulphur content, which factor lends interest to the installation. Details of the operation of this plant are not available for publication. However, the process is reported to be somewhat similar to that of Thermatomic Carbon Company, which operates a plant at Monroe, Louisiana. This latter company makes use of the so-called matlock furnace. The gases from this furnace are lowered in temperature in a cooler, the black separated therefrom by suitable filters and the separated black thereafter pneumatically conveyed to storage. The product of the "smokeless" plant at Pampa, Texas, is marketed to rubber companies who have been cooperating in the development of the process insofar as

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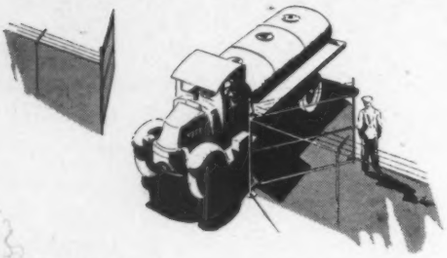

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the utilization of the product is concerned. What is available for publication on this process appeared in THE REFINER AND NATURAL GASOLINE MANUFACTURER, issue of February, 1928, page 87. (See Bibliography for other citations).

In connection with a discussion of processes and blacks the following comparative analysis of several types of black from various processes is of interest (taken from a general report of Chemical Atlas Chemical Company).

Type of black—	Oil absorption c.c. linseed oil per 100 grams black	Iodine absorption grams per 1000 grams black	Moisture	Acetone extract	Ash	Specific gravity	Color value
Ink	146	79.0	6.0	0.36	0.02	1.88	100
Channel	140	57.0	2.5	0.20	0.10	1.73	100
Gastex	100	22.0	0.5	0.50	0.08	1.82	50
Acetylene	296-350	43.0	0.2	0.36	0.05	1.84	50
Lampblack	130	9.2	3.0	0.84	0.10	1.73	20
Thermatomic ..	46	6.1	0.1	0.47	0.30	1.84	13

In the foregoing comparison it is noted that color values vary for given type of carbon black produced by different processes. This varying in color value occurs with the individual process when all conditions of manufacture are not right. There are many shades of black carbon, and there is a gray carbon, which is a hard substance of impaired color and not classified as carbon black. It is not generally known that carbon black can be produced in as many various shades or degrees of blackness as gasoline is white, for example.

TEXTURE AND FINENESS IMPORTANT

Texture and fineness are also of importance. Gray carbon in the channel process occurs when heat is too high,—therefore the control of temperature in burning houses becomes of the utmost importance. This being true, one of the most important factors in the manufacture of carbon black becomes the weather, and wind. Rain affects the draft, effects the flame, and cools the burner houses. Winds blowing across the burner houses in one direction produce a different result from winds blowing down between the long sheds or in the alleys. All such variable conditions influence the properties of the finished product.

In the recently issued Report of Investigation No. 2991, March, 1930, Bureau of Mines, Wm. W. Odell outlines in detail the results of experiments at Louisville, Kentucky. "Cracking Natural Gas in Water-Gas Generators With Recovery of Carbon Black," wherein the apparatus used was a water gas generator containing a bed of ignited fuel. The report states: "It was found that natural gas could be almost completely cracked in the generator fuel bed, yielding more than two volumes of gas containing as much as 90 to 92 per cent of hydrogen, and evolving more than 32 pounds of carbon black per 1000 cubic feet. The gas of course, can be readily recovered, but only a small proportion of the carbon evolved can be recovered as carbon black. As changes were made in the cycle, method of opera-

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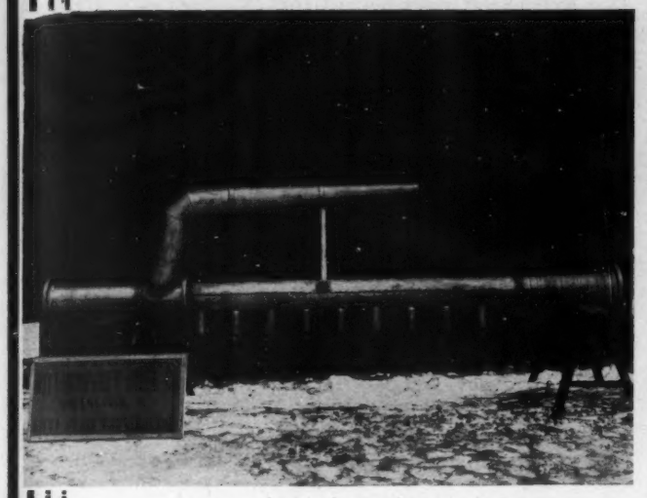

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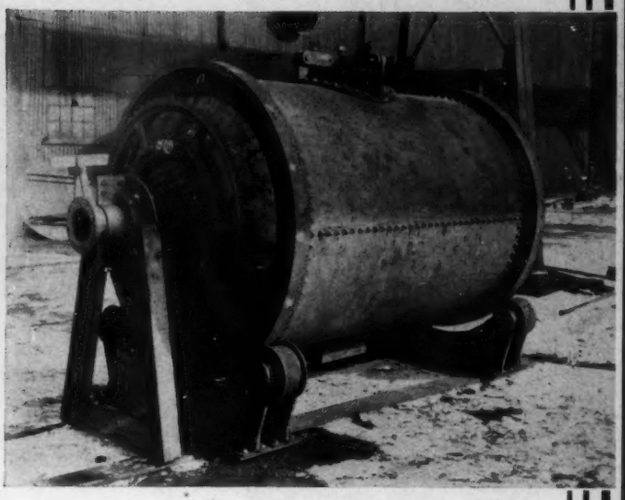

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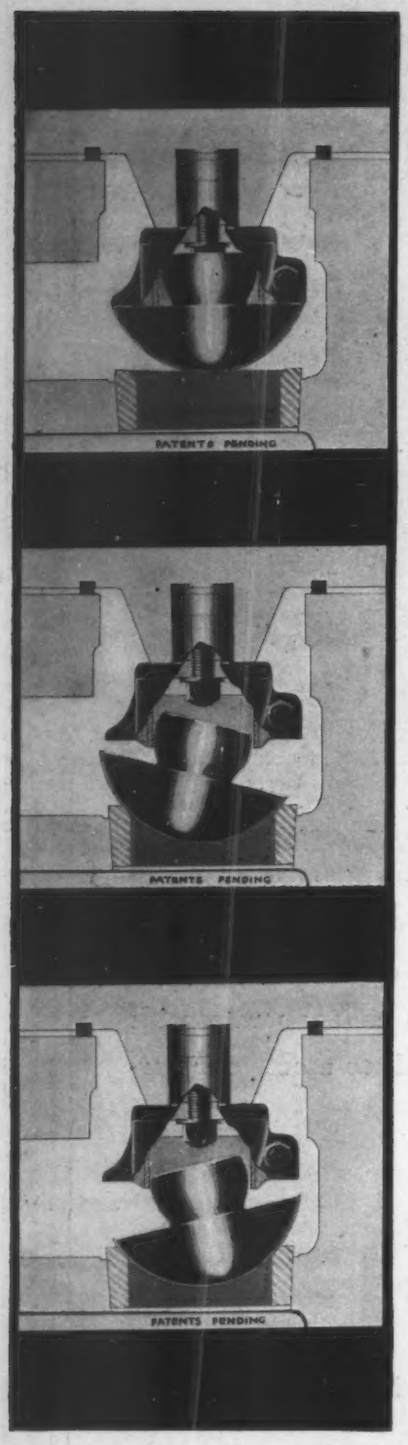

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tion and the size of fuel used, the yield of carbon black (carbon carried out of the generator entrained in the gas) varied from about four pounds to more than eight pounds per thousand cubic feet of natural gas cracked . . . "

"The carbon recovered had a grayish cast, and the samples tested contained somewhat more extractable matter than is usually found in high grade carbon black. And extraction with benzol for 24 hours indicated that 1.74 per cent was soluble. Proximate and ultimate analysis were made on the same sample lot as follows:

Composition of Carbon black, per cent

Constituent	Same as received	Sample, moisture free
Proximate analysis		
Moisture	0.3	0.0
Volatile matter	2.7	2.7
Fixed carbon	95.1	95.4
Ash	1.9	1.9
Ultimate analysis		
Hydrogen	1.0	1.0
Carbon	96.2	96.4
Nitrogen	0.1	0.1
Oxygen	0.6	0.4
Sulphur	0.2	0.2
Ash	1.9	1.9
Colorific value—		
B.t.u. per pound	14,460	14,500

"Although these tests are helpful in classifying the carbon it must be admitted that the relative value of carbons for use in the rubber and other industries can not be definitely established by laboratory test. For this reason and because certain properties of the carbon can be altered by merely changing the operating procedure, the writer will not attempt to estimate its possible value. It is reported that a value of five to seven cents a pound has been assigned it, based on sample submitted to prospective buyers.

The report by Mr. Odell concludes that natural gas can be cracked in a water gas generator by making alternate air blasts and gas runs, and lists the uses for such gas as is produced. Further, it reports that carbon black can be recovered in making this gas in amounts approximating seven pounds per 1000 cubic feet, and this black will have a value from three to seven cents per pound. The author states that "The process is worthy of further study, and, if a reasonably high price can be obtained for the carbon black, it should be developed."

In the preparation of this series of articles the writer has drawn freely upon the previous work of Fulton, Cabot, Kaufman, Odell, Beaver and Keller, and others, as cited in the following Bibliography, and full acknowledgement is due.

Bibliography courtesy Florence Lundell, Technical Librarian, Tulsa Public Library.

American Gas Journal—Carbon black produced from natural gas—1926-27—V. 130, Jan., 1929, p. 48.

Beaver, D. J., and Keller, T. P., Effects various types of carbon

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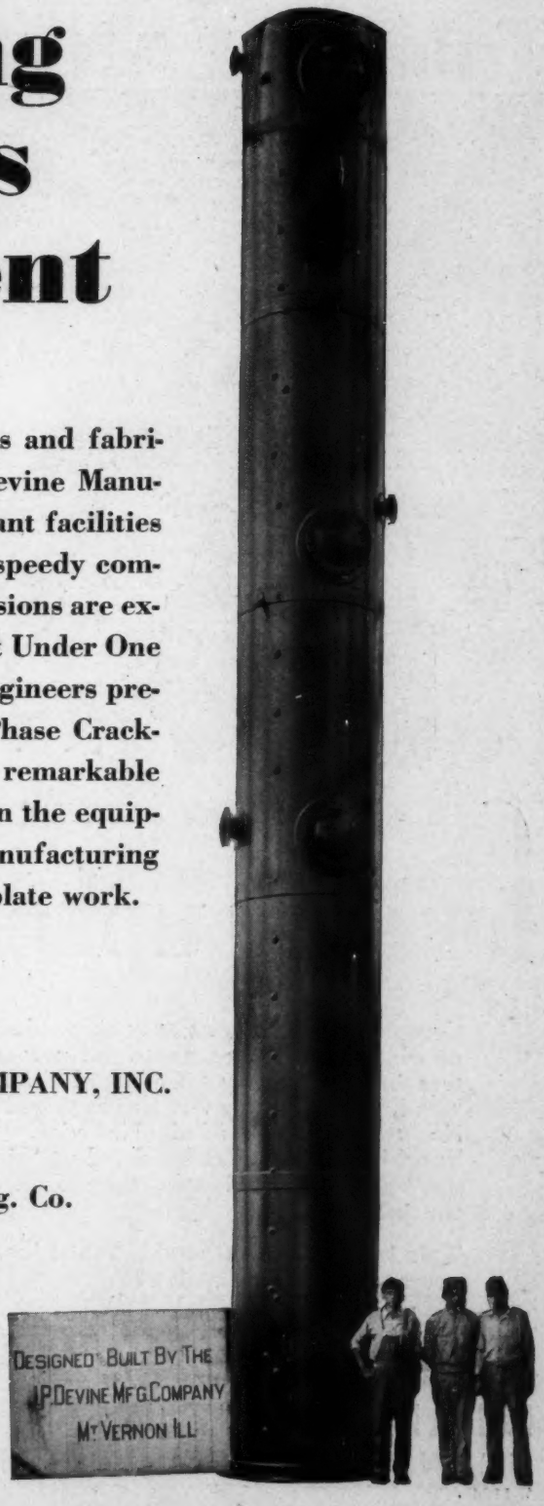

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black on certain physical properties of rubber compounds. Ind. & Eng. Chem. V. 20, Aug., 1928, pp. 817-819.

Cabot, T. D., Origin and devl. carbon black industry—O.&G.J., Oct. 13, 1927, p. 68.

Carbon Black in 1927. Oil Paint and Drug Reporter, V. 113, May 28, 1928, p. 38, D. Chemicals. V. 29, May, 1928, p. 7. Excerpts Chem. & Met. Eng. V. 35, June, 1928, p. 381. Min. Cong. Journ. V. 14, June, 1928, p. 449. Rubber Age, V. 23, June 10, 1928, p. 260. Gas Age, V. 62, Sept. 15, 1928, p. 318.

Carr, R. L., Carbon Black a business need. O.&G.J. June 16, 1927, p. G-198.

C. E. Bowles. Carbon Black's position in industry—O.&G.J. May 15, 1924, p. 34.

Chatfield, J. C., Burner control at Monroe, etc. Nat. Pet. News, V. 18, June 16, 1926, p. 59.

Chem. & Met. Eng. Carbon Black Output Increases 100 per cent in 1924. Jan. 19, 1925, p. 140.

Gas Age. La. launching plan to save nat. gas. V. 51, May 12, 1923, p. 620.

Goodwin, Morris, and Park, C. R., Carbons blacks and their use in rubber. Ind. and Eng. Chem. June, 1928, p. 621. July, p. 706, Oct. p. 1088.

Hopkins, G. R. Carbon Black produced from natural gas. U.S.B.M. Mineral Resources of U. S. 1925, part 2, p. 53.

Inland Oil Index. Brisk demand for carbon black. June 1, 1928, p. 6.

Jakosky, J. J. Electrical Mfgr. of carbon black. U.S.B.M. Tec. paper 351.

Johnson, C. R. Study of carbon black. Ind. & Eng. Chem. Sept. 1928, pp. 904-908.

Linz, C. L. Electrical process makes carbon black from distillates. Refiner and Nat. Gaso. Mfgr. Sept. 1925, p. 29.

Mantell, C. L. Industrial carbon. 1928, Chapter 10, Carbon Black, p. 69.

Nat. Pet. News. La. Leads carbon black output. V. 14, May 3, 1922, p. 29.

Neal, R. O., and Perott, G. St. J. Carbon black, its mfgr. properties and uses. 1922, (Bibl. pp. 80-92) U.S.B.M. Bulletin 192.

O. & G. J. Carbon black ind. shows gain etc. V. 28, June 13, 1929, p. 96.

Oil Weekly—Manufacture of Carbon Black—July 22, 1922, 9. 12. Possibilities of carbon black from waste gas in Canada—April, 1924, p. 47.

Plummer, W. B., and Beaver, D. J. Abrasion tests of rubber stocks containing various types of carbon blacks. Ind. and Eng. Chem. Sept. 1928, p. 895.

Reid, George. Carbon Black production under conservation rules. The Oil Weekly, Dec. 2, 1927, pp. 73-75 and Refiner and Nat. Gaso. Mfgr. Dec. P-64.

Richardson, G. B. Carbon black produced from natural gas. U.S.G.S. Mineral Resources of U. S. part 2, 1920, pp. 145-149. part 2, 1921, pp. 33-37.

Scientific American. Carbon Black, a natural gas product. V. 128, Jan. 1923, p. 47.

Seivers, E. G. Carbon black produced from nat. gas. U.S.G.S. Mineral Resources of U. S. part 2, 1920, pp. 145-49. Production of carbon black in 1921, Gas Age. V. 50, Aug. 12, 1922, p. 209. Report on carbon black ind. O.&G.J., Aug. 5, 1921, p. 90.

Smith, L. R. Carbon ind. is opposed by Smith. O.&G.J. Jan. 10, 1918, p. 32.

U.S.G.S. Min. Resources of U. S. Part 2, 1923, p. 1488. "Carbon black."

Cabot, T. D. Bulk of carbon black made from residue gas. O.&G.J. May 2, 1929, p. 78.

Carson, C. M., and Sebrell, L. D. Some observations on carbon black. Ind. and Eng. Chem. V. 21, Oct., 1929, p. 911.

Oil Fld. Eng. Efficiency enters mfgr. of carbon black. Nov. 1929 p. 28.

Kaufman, H. L. Progress in carbon black ind. Oil Weekly, V. 54, Aug. 9, 1929, p. 31.

Yunker, J. A. New cracking method perfected, nat. gas. prods. broken down with carbon black as by-prod. O.&G.J. May 9, 1929, p. 111.

Reid, George. Smokeless Carbon black plant operation. Refiner and Nat. Gaso. Mfgr. Feb. 1928, p. 87.

O.&G.J.—New Smokeless Carbon Black Plant. Dec. 6, 1928, p. 237.

Bureau of Mines—R.I.—2991. March 1930—Wm. W. Odell—Cracking natural gas in water—gas generators with recovery of carbon black.

The Application Of the New Natural Gasoline Specification

Paper read before Western Petroleum Refiners Association, March 10-12, 1931

By S. S. SMITH
Shell Petroleum Corporation

AT the Shreveport meeting last year the Natural Gasoline Association made a number of vague promises concerning the research work under way and the specifications which would soon be forthcoming. This year we offer the finished specifications and are prepared to illustrate the use and effectiveness of them in the refinery.

Natural gasoline is mainly valuable because of one thing—its volatility. Secondary values of natural are to improve the knock rating of your finished fuel, and perhaps with some to improve the finished gravity. The volatility of a natural is a direct function of its composition in terms of its two lighter components—butane and pentane. Propane is intentionally omitted from the lighter components in the expectation that all will agree that it has no place in a finished motor fuel blend, and that therefore it has no place in a blending stock such as natural. Hexanes, heptanes and octanes are already present in refined stocks, and therefore their sale in natural gasoline is incidental, and brought about by the fact that they serve as solvent agents for the more valuable volatile components.

The new specifications revolve around the foregoing assumptions, using the 140° F. per cent evaporated as the index of the butane and pentane composition and qualifying this with the Reid Vapor Pressure at 100° F. to differentiate between butane-pentane and propane-butane. The specifications are as follows:

Chart A

Grades of Natural Gasoline

Vapor Pressure, Lbs. Per Sq. In. Abs., at 100° F. (Reid)	Percentage Evaporated at 140°F 25–40	40–55	55–70	70–85
34	Grade 34-25	Grade 34-40	Grade 34-55	Grade 34-70
30	Grade 30-25	Grade 30-40	Grade 30-55	Grade 30-70
26	Grade 26-25	Grade 26-40	Grade 26-55	Grade 26-70
22	Grade 22-25	Grade 22-40	Grade 22-55	Grade 22-70
18	Grade 18-25	Grade 18-40	Grade 18-55	Grade 18-70
14	Grade 14-25	Grade 14-40	Grade 14-55	Grade 14-70
10				

Natural gasoline is a liquid petroleum product consisting of the heavy hydrocarbons extracted from natural gas by such means as compression absorption and other processes.

Natural gasoline is defined further for commercial purposes by the following specifications.

1. Vapor pressure—10 to 34 pounds per square inch absolute at 100° F. (Reid).
2. Percentage evaporated at 140° F.—25 to 85.
3. Percentage evaporated at 275° F.—not less than 90.
4. End point—not higher than 375° F.
5. Corrosion—non-corrosive.
6. Doctor test—negative, "sweet".
7. Color—not less than 25 (Saybolt).

In addition to the above general specifications, natural gasoline shall be divided into 24 possible grades on a basis of vapor pressure and percentage evaporated at 140° F. The maximum vapor pressure of the various grades shall be 14, 18, 22, 26, 30 and 34 pounds respectively. Each grade shall be designated by its maximum vapor pressure and its minimum per cent evaporated at 140° F as shown in Chart A.

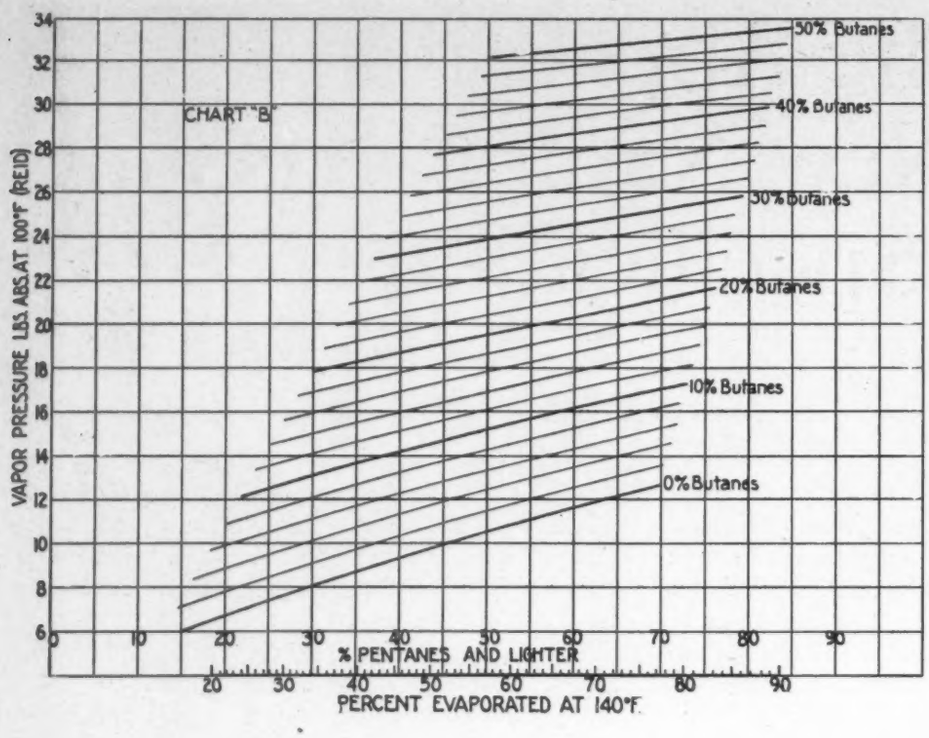
SEVERAL MINOR CHANGES MADE

In addition to the changes in volatility specifications described in the preceding, several minor changes have been made, as follows:

(1) An omnibus requirement has been included, stating that the A.S.T.M. per cent evaporated at 275° F. shall not be less than 90.

(2) It has been considered necessary to standardize the doctor test as applied to natural gasoline.

It will be seen that the grades range in vapor pressures from 14 pounds maximum to 34 pounds maximum and the volatility ranges are inclusive as follows: 25-40, 40-55, 55-70, and 70-85. The ranges of per cent evaporated at 140° F. and the Reid vapor pressures within each grade are picked so that in a finished blend of 15 per cent natural the vapor pressure will be controlled within one pound and the 10 per cent point will be controlled within 5° F. by use of specification grade alone. Since there are six



vapor pressure ranges and four volatility ranges, 24 grades result. This may seem an excessive number of grades, and may seem to make of the grading system, which is excessively complex. However, in order to accomplish the purpose of the grading system, either a large number of grades must be used or there must be substituted a complex relationship between vapor pressure and volatility. Our purpose as stated above was to evaluate the gasolines in terms of volatility and/or composition.

Chart B illustrates the relationship existing between the percentages evaporated at 140 plotted as abscissa and the Reid Vapor Pressure plotted as ordinates, on the one hand, and the composition per cent of pentane and lighter as secondary abscissa with the composition per cent of butane plotted as equal percentage contours on the other hand. This chart shows clearly how the reference points of the specifications actually fit the compositions of the natural gasolines. These relationships have been in active use by several companies for about a year and have been repeatedly checked both by analysis and by synthetic blends and found to be highly accurate. You will note that propane has been omitted from consideration in this chart.

CHART C

Chart C shows a slightly different setup of the butane and propane compositions of a natural. Here we have the same 140 degree points used as abscissa against the Reid Vapor Pressures as ordinates, with the grade structure of Chart A superimposed and the percentage butanes and propanes sketched in as contours. This chart is not intended as an extremely accurate indication of the composition of natural gasolines but is intended to show average compositions of natural gasoline resulting from normal manufacture with reasonably efficient secondary rectification. This Chart C is made up from data arrived at by rectification and analysis of samples from 12 plants each carried down to 40 per cent off at 140°F.

At this time I wish to point out that it is almost impossible to put together a synthetic blend which will meet the grades below the propane free line if either butane is substituted for pentane or propane for butane. Such a blend will inevitably fall into the grades shown on Chart C as above the propane free line. I would like to amplify this statement and make it clear that substitution of butanes for pentanes will increase the per cent evaporated at 140°F. or will increase the vapor pressure. In either event this will move the particular gasoline upward in vapor pressure grade or will decrease its volatility grading. The statement is not intended to convey the impression that gasolines above the propane free line are not usable. On the contrary, they are highly efficient blending agents for certain purposes. However the majority of users of natural now are trying to increase volatility while retaining or lowering vapor pressures. The same tendencies are evident in the increasing use of pressure distillate stabilizers or other means of effectively controlling the vapor pressures of refinery stocks. The effort of the Natural Gasoline Association has been to reflect progress in specifications in the same general direction as does technical progress in the refineries.

If purchasers of the new specification naturals will use those composition data sheets in arriving at desired gasolines and if I am correct in assuming that you can use propane free gasolines to better advantage, then we have immediately decreased our number of grades for probable use. These propane content gasolines are 34-40, 30-40, 26-40, 34-55, 30-55 and 34-70. In addition, parts of 30-70, 26-55 and 18-40 fall above the line. However, it will be found in use that if these latter three grades are made by ordinary good fractionation they will be essentially propane free with a slightly reduced butane content.

It is possible now to make the general statement in connection with the new specifications, that the lower the vapor pressure and the higher the volatility, the more difficult it is to manufacture, but the

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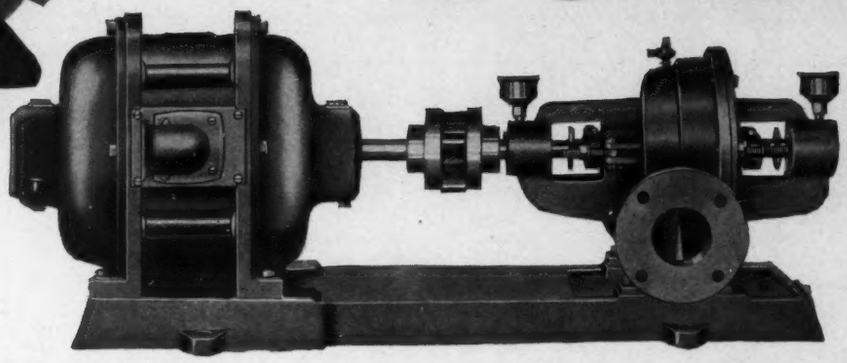

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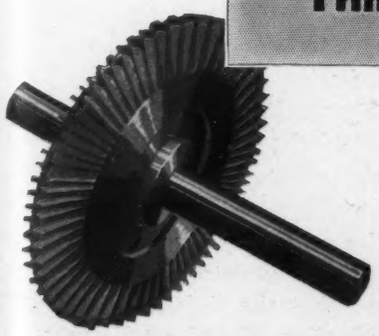
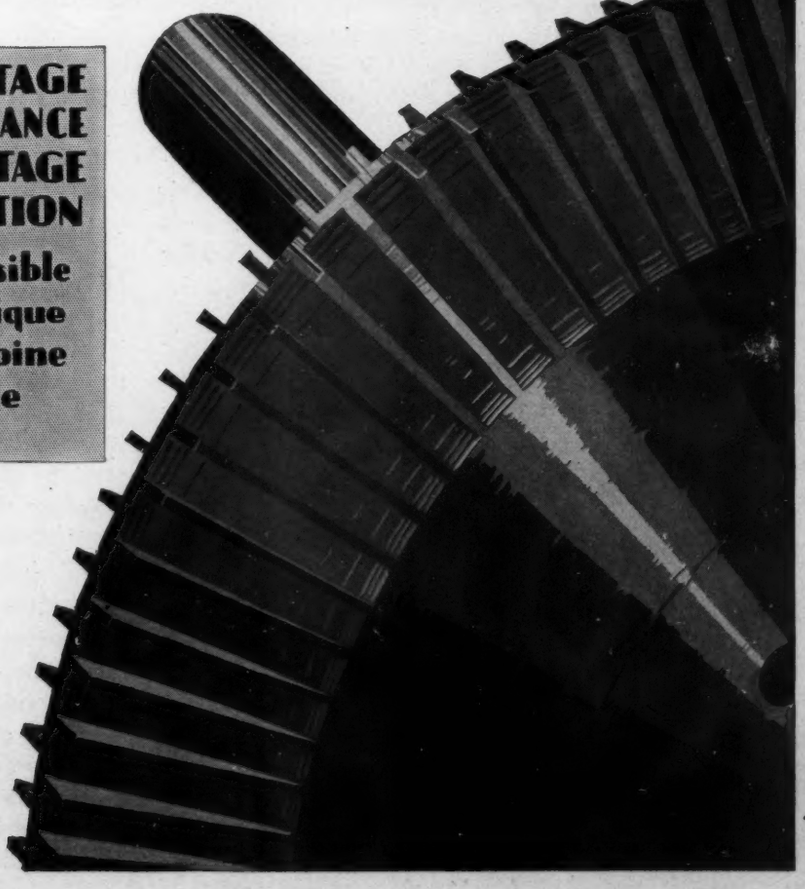
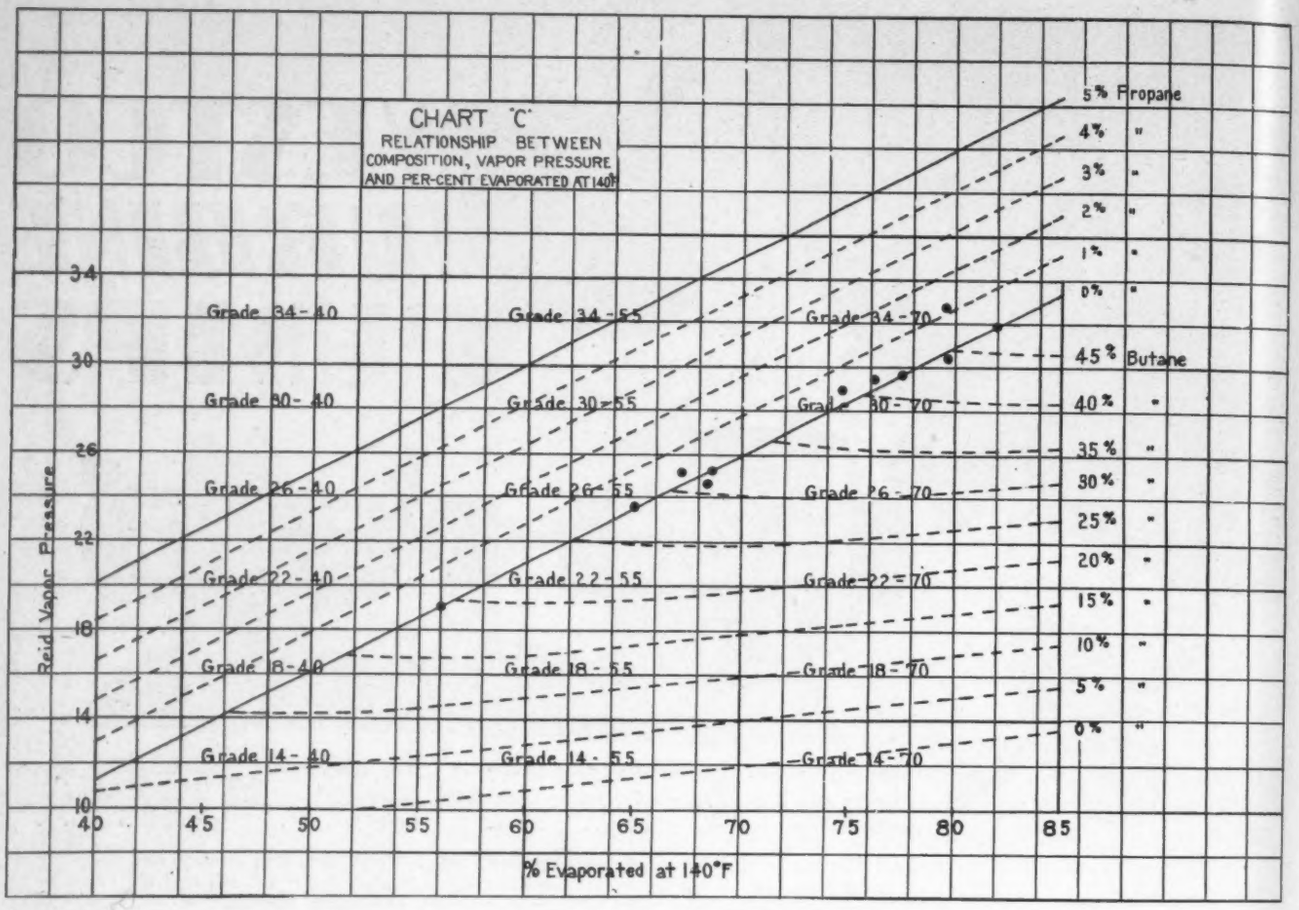






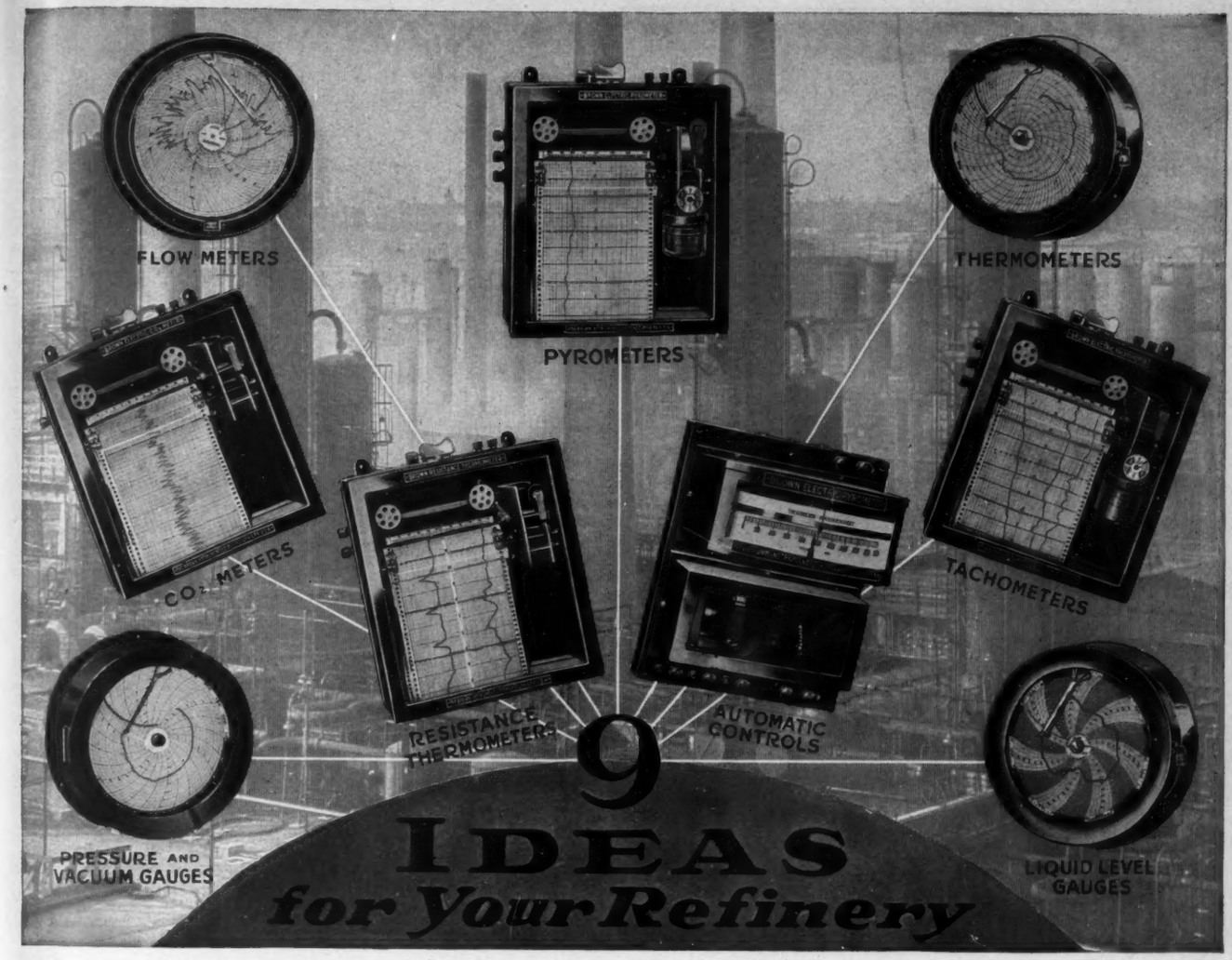
more valuable it is to the blender in controlling volatility with control of vapor pressure. On the other side of the chart, while it is possible to make 14-70 gasoline, the writer has never seen any and it is extremely doubtful whether any of it will appear on the market, so that we may now consider our useful grades cut to 17.

These 17 grades, then correspond to our old grading system which included five grades, of which only one received large volume consideration. This brings us to a logical consideration of the reason for 17 grades and how they may be made to serve the greatest use in the refinery.

In the first place I assume that all agree, by and large, with authors well known to the industry, who have shown that the vapor pressure of a motor fuel is the best index of its vapor locking tendencies, I also assume that each in some form or other, uses the A.S.T.M. distillation points along the front end of the curve for the purpose of evaluating the starting qualities, warming up and acceleration ability, and perhaps to some extent the detonating qualities of your finished fuels. With these assumptions in mind the new specifications for naturals become something actually related to the finished motor fuel instead of merely letters in a grading system as in the past.

We know that the vapor pressure of a finished blend is a function of the molecular percentages of the materials used in blending. Molecular percentages are a nuisance to handle in the ordinary computation methods, particularly if they are to be used in a large number of routine calculations. With this in mind there is presented Chart D which by straight edge calculations and using ordinary specification distillation points, converts volume percentages of natural and refinery naphthas or gasolines into their corresponding molecular percentages. Supplementing Chart D is presented Chart E which uses the molecular percentages determined from the former to evaluate the vapor pressure of a finished blend. In use this chart solves for any one of the unknowns if the others are known of, vapor pressure of natural, vapor pressure of blending stock, vapor pressure of finished blend, and per cent of natural in the blend by volume. It uses the familiar method of straight edge calculation as follows: Given the vapor pressure of refinery stock, the vapor pressure of natural to be used, and the vapor pressure of finished blend desired, and solving for volume per cent of natural to use.

Assume that the vapor pressure of refined stock is 3.6 pounds, the vapor pressure of natural available is 26 pounds and that the finished blend is to be an eight-pound gasoline. On Chart E are connected the vapor pressures of the blending materials and at the point where this line crosses the eight-pound line a vertical is dropped to the base scale, reading



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For indicating, recording and controlling temperatures ranging up to 800° F. where the instruments may be located at relatively short distances from the points where the temperatures are to be taken.

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For indicating, recording and controlling low temperatures such as are encountered in de-waxing plants.

TACHOMETERS

For indicating, recording and controlling speeds of pumps, fans and other machines in the refinery.

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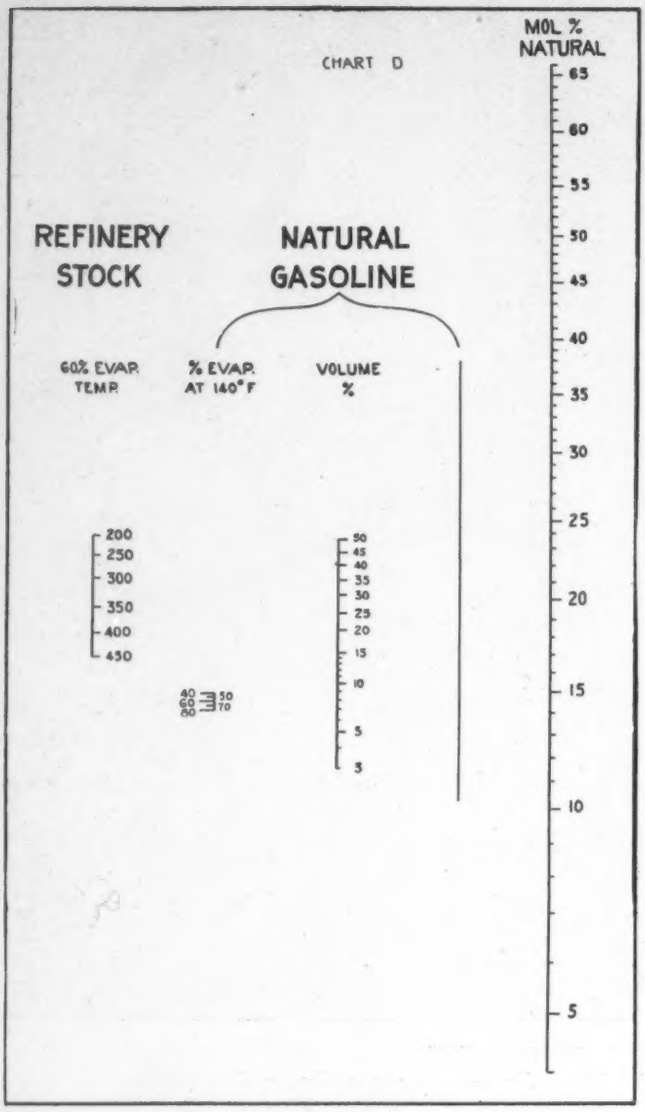

20 mol per cent of natural desired in the blend. On Chart D, the figure of 20 mol per cent of natural is connected with the 60 per cent evaporated temperature of the refinery blending stock and the point of contact of this line with the dummy scale is used as a pivot to connect a new line to the per cent evaporated point of the natural. The intersection of this new line with the volume per cent of natural scale determines the desired composition of natural in the blend, in this case 16 per cent.

Since there were certain assumptions made in the construction of this chart, it might be well to discuss them. First, it was assumed that the 60 per cent evaporated temperature of the refined stock was roughly an index of the average boiling point of the naphtha. Second, it was assumed that the average boiling point of the naphtha determined the molecular weight. This assumption, it is conceded, stretches a point of truth. It would be true if the composition per cents of unsaturates, saturates and cyclic compounds remained constant, but it is recognized that these factors vary. However, when the gravity and molecular weight are tied together into one factor as we have done in this instance we are inclined to think that our assumptions are not inaccurate enough to seriously affect the finished result. The molecular constants used in Chart D with respect to natural gasoline were evaluated from composition per cent and are correct within the limits of error in the use of the chart.

Use of this chart on a large number of blends shows that the inaccuracies resulting from incorrect interpretation of the molecular weights of the refined stocks are not sufficiently great to exceed the limits of experimental error of the finished vapor pressures. Our check tests in the use of this curve have not included as much cracked stock as we would like, and if in use in the blending of heavily cracked pressure distillate stocks this chart shows a constant deviation from actual results, it may be necessary to slightly correct the gauge points for the 60 per cent evaporated temperatures of the refined stocks. In our own use of this chart we have found a maximum deviation from experimental data to be about three-tenths pound Reid.

A subsidiary use of this chart is in the blending of natural gasoline with refined stocks to obtain better anti-knock rating in the finished fuel. For this purpose the vapor pressure scale may be rescaled to read in terms of benzol equivalent, octane number of H.U.C. of the respective blending materials. Results of use of this curve for such blending will be well within the limits of experimental error. Natural gasoline may be taken as having an octane number of 45 plus its vapor pressure. Thus a 20-pound gasoline will have an octane number of 65, a 30-pound gasoline an octane number of 75, etc. These figures are not exact but are reasonably close and I believe conservative. They apply of course only to well fractionated gasolines of average butane pentane composition.

CHART F

For my next chart I am indebted to R. C. Alden, Phillips Petroleum Company. This chart, which is reproduced as Chart F, relates the distillation points of the two blending stocks into the finished distillation points of the blend. It also is a straight edge chart and is accurate within experimental limits for percentages off up to about 212° F. From this chart and the distillation curves of the two blending stocks can be predicted the entire front end distillation points of the finished blend. To use, simply connect the per cents evaporated at given temperatures of the two blending stocks and read below intersection of this straight line with the percentage natural used the percentage evaporated at reference temperature in the finished blend.

Given the last three blending charts and the specifications of the blending stocks, it should be possible to derive almost any sort of finished front end volatility curve in the blend which one might desire.

This statement brings us back to the original con-

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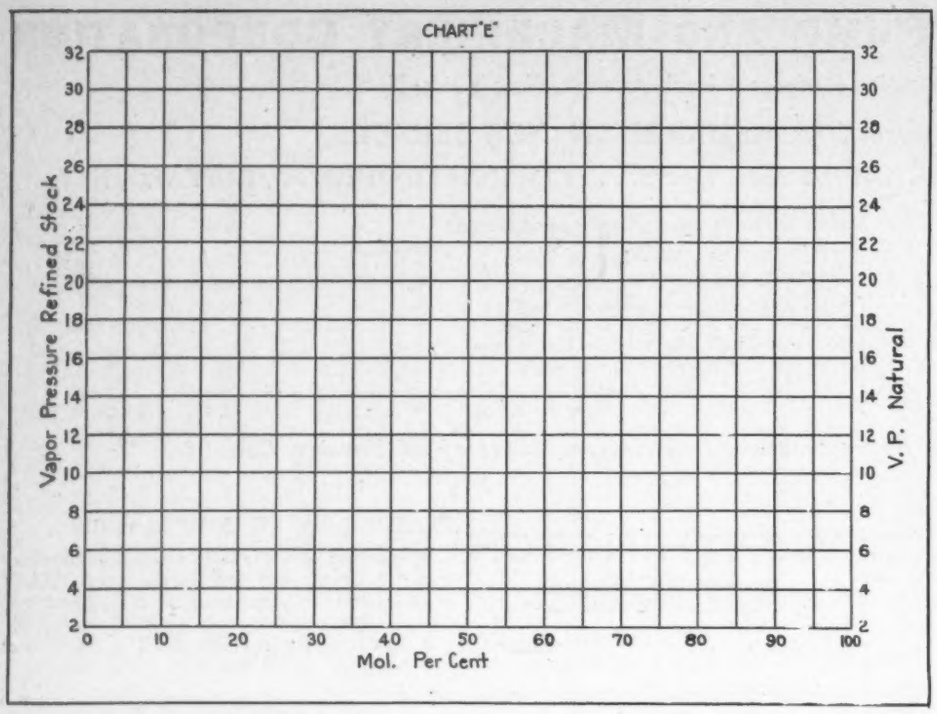


sideration for the large number of grades in the new grading system, and gives me at least an opportunity to present some of the reasons for making rather fine distinctions in the specifications of our naturals.

Some refiners doubtless will want to use just as little natural as possible and still maintain their finished fuels at or close to their desired specifications. In this event that refiner will doubtless use a natural like a 26 or 30-70. This will give him in few gallons concentrated volatility while still assuring him that he is not going to have a lot of wild constituents in his finished stock which will give trouble due to excessive handling losses, loss of starting quality due to reduced vapor pressure at point of consumption, etc. On the other hand, the same refiner at some other time of the year or at slightly changed market conditions may desire to work off as much natural as possible in a given blend. For that refiner we have grades such as 14-40, 14-55, and 18-55 which can be used up to the limit of vapor pressures in his finished fuels while still not detracting in any way from the performance characteristics of his finished motor fuels. This brings to mind another use of the molecular percentage relationships given in Charts D and E.

12 PER CENT AVERAGE

The figures of consumption of natural gasoline against the use of refined stocks show that there is average use of about 12 per cent of natural in total fuel sold. Practically all refinery stocks at present will stand up to 20 per cent blend of natural gasoline, with improvement in their performance characteristics. Many naphthas will improve with addition of as much as 35 per cent of natural gasolines and I know of blends in common use which actually go higher than 50 per cent.

Since the evolution of the new specifications and the better understanding of blending possibilities that have come with our studies along this line, we in the natural gasoline industry still feel that we are justified in saying that we have something of value to the refiner which in many cases the refiner is ignoring to his own detriment.

It must be understood in making this statement I do not mean that there should be indiscriminate use of high vapor pressure natural gasoline. I recognize that the vapor pressure of finished motor fuel should be very carefully controlled and that the improper use of excessive vapor pressure may be exceedingly harmful. However, with the new specifications, and the resultant possibility of buying and using vapor pressures as low as 14 pounds, there is no reason for hesitancy in using any amount necessary to get the desired distillation ranges.

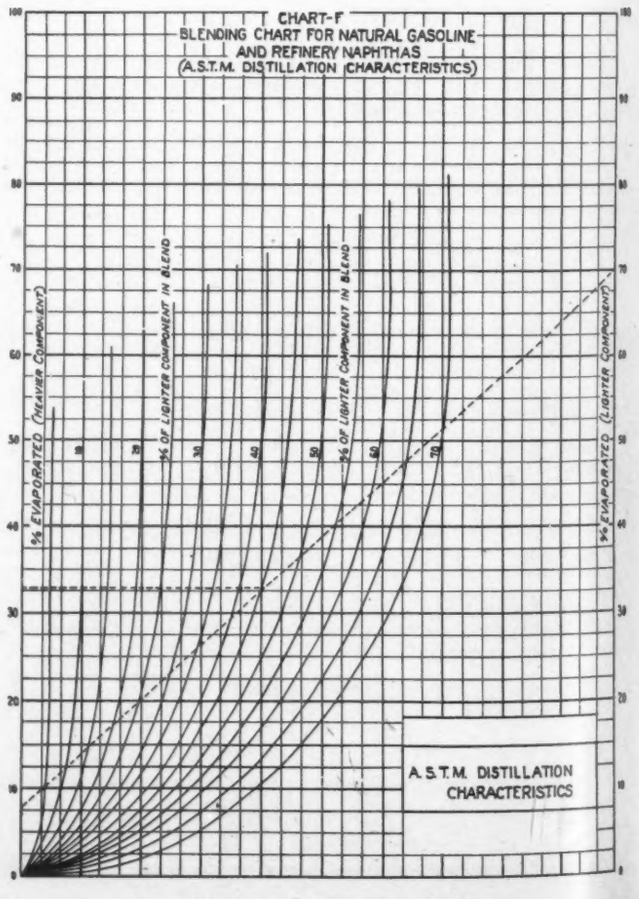
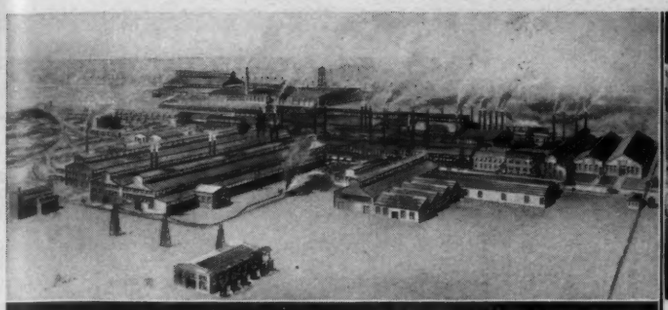


CHART-F
BLENDING CHART FOR NATURAL GASOLINE AND REFINERY NAPHTHAS
(A.S.T.M. DISTILLATION CHARACTERISTICS)
% EVAPORATED (HEAVIER COMPONENT)
% OF LIGHTER COMPONENT IN BLEND
% OF LIGHTER COMPONENT IN BLEND
% EVAPORATED (LIGHTER COMPONENT)
A.S.T.M. DISTILLATION CHARACTERISTICS



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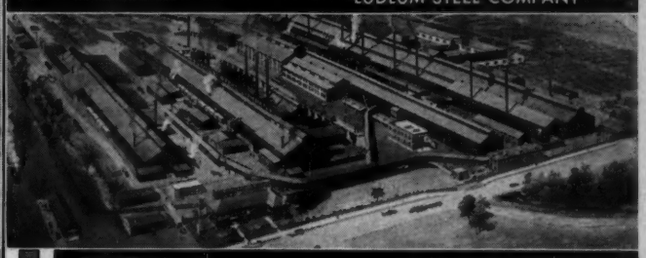

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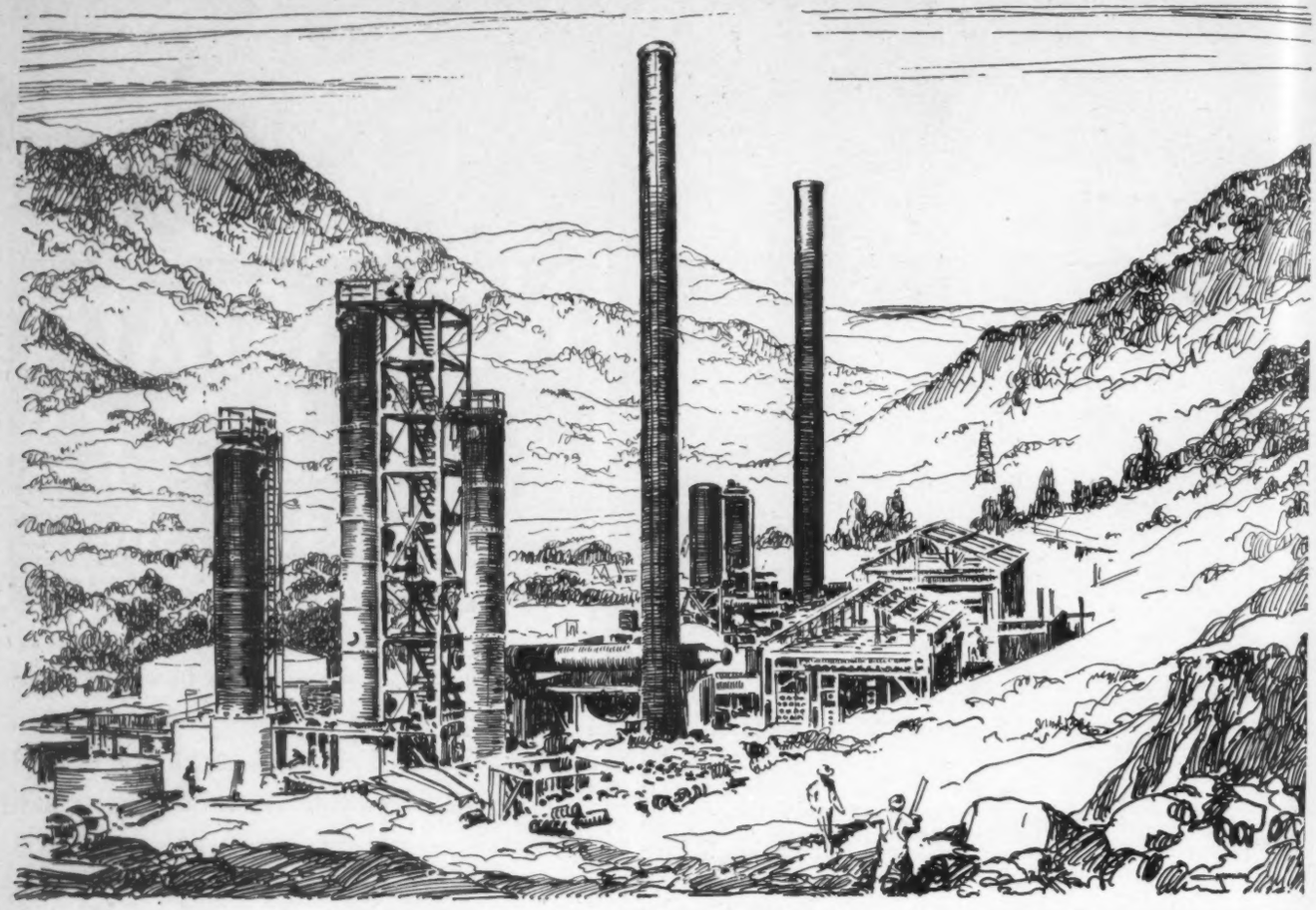

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The Application of Equations of State to the Natural Gas Industries

By I. N. BEALL
Chemical Engineer

BOYLE'S law states that at constant temperature the product found by multiplying the volume of any gas by the absolute pressure is a constant for all pressures that is $P_1V_1=P_2V_2=$ a constant. Thus if the pressure $P_1=1$ and $V_1=1$, then at pressure $P_2=2$, V_2 must equal ½ by the formula. If, however, the temperature is different at P_2V_2 will be either smaller or larger than P_2V_2 then P_1V_1, depending whether the temperature is lower or higher at P_2V_2.

The temperature correction may be introduced into the pressure volume relationship by another general law for gases (Charles' law) which states that the volume of a gas under any condition of constant pressure is the proportional to the absolute temperature. In the English system of units, degrees Fahrenheit are converted to degrees absolute (degrees Rankine) by the formula °Abs=460+°F. By Avogadro's law, equal volumes of every gas under identical conditions of temperature and pressure contain the same number of molecules. Now, insofar as matter is concerned, pressure, volume, and temperature are variables but the mass is a constant quantity. Therefore, from a consideration of Boyle's, Charles' and Avogadro's laws under constant conditions of pressure and temperature, the volume of a unit quantity of every substance capable of existing as gas at those pressures and temperatures multiplied by its molecular weight will be the same.

In the English system of engineering units, the pound is taken as the unit of weight, therefore one pound of a substance times its molecular weight is designated as the mol-pound. Experimentation has established the pound molal volume for perfect gases as 359 cubic feet at 32°F and 760 millimeters of mercury (1 atm). If V equals molal-volume equals 359 of 1 pound-mol of any gas under the above conditions then

$$V=\frac{359\times 1}{(460+32)}=0.73=\text{a constant and}\frac{0.73T}{P}$$

where P is any pressure in atmosphere and T is any temperature in degrees Rankine (460 °F), expresses the general pound molal volume in cubic feet for any gas under those conditions. Thus, if T equals 60°F and P equals two atmospheres absolute, then the calculation

$$\frac{0.73\ (460+60)}{2}=190\text{ cu. ft.}$$

Natural gas is sold on either a 4 oz. or 2 lb. basis, the temperature at 60°F.

$$\frac{0.73\ (460+60)}{\frac{14.95}{14.70}}=372\text{ cu. ft.=Vol. one lb.-mol @60°F 4 oz. base}$$

$$\frac{0.73\ (460+60)}{\frac{16.70}{14.70}}=334\text{ cu. ft.=Vol. one lb.-mol@60°F., 2 lb. base}$$

On the basis of the foregoing calculations the specific density of any substance in the gaseous state can be predicted if the average molecular weight is known together with the temperature and pressure. The specific gravity of gases are usually taken on the basis of air equals 1, the average molecular weight of air equals 28.95 so if the average molecular weight of a gas equals 20, its specific density compared with air 20÷28.95=0.692 sp. gr. Logically the reverse holds so the average molecular weight of any gas is the average specific gravity under standard conditions times 28.95. 28.95 × sp. gr. = mol. wt.

Deviations from the Gas Laws.—SUB ut

For a great majority of the engineering calculations pertaining to natural gas plant design and control, the foregoing laws hold with reasonable and sufficient accuracy, particularly at ordinary pressures and temperatures. At high pressures the perfect gas laws do not hold, neither do they hold for temperatures and pressures in the region close to where liquefaction takes place. Gas volumes cannot be predicted with sufficient precision by the general gas laws under such conditions.

Fortunately all matter has the property of mass

which is neither affected in measurable amount by either temperature, pressure, time or volume. No variables have to be fixed to define weight, a pound of methane, ethane, propane or what not, still weighs a pound no matter how much the volume, temperature or pressure may vary.

It has already been shown how the molecular weight of a gas may be calculated from the specific gravity by the simple expedient of multiplying by the average molecular weight of air on the assumption of the holding of general laws pertaining to all matter under various conditions of temperature and pressure. The molecular weights of all elements and compounds are constants, but for the present purposes the term "apparent molecular weight" will be used. As illustration one mol pound of gas at S.T.P. = 359 cubic feet. By the perfect gas laws the volume is inversely proportional to the pressure at constant temperature so at 10 times the pressures, the volume would be $359 \times .1 = 35.9$ cubic feet. If the density of the gas is 1 at S.T.P. at P=10, the density will be 10.

Suppose, however, the volume at P = 10 is not 35.9 but 30, then the density will be 359÷30=11.97 and the specific gravity 11.97÷10=1.197. On the basis of unity specific gravity the molecular weight =28.95, therefore at P=10 the "apparent molecular weight" = $1.197 \times 28.95 = 34.6$. Similarly, when the temperature correction is applied to gases that do not follow Charles law, the deviation can be provided against by use of the "apparent molecular weight".

Fortunately, for most calculations involving natural gas, the temperature ratio is small. It takes 580°F at constant pressure to increase the volume of a gas at 60°F. 100 per cent.

$$V \times \frac{(580+460)}{520} = 2.$$

By the same law, 1100°F would be necessary to make the volume three times the original.

The volume change due to heat is where a liquid vaporizes at constant pressure. Pure compounds vaporize at constant temperature, if the pressure remains constant, heat is added but it is no longer heat such as is evidenced by temperature rise, as it has been taken up or transformed into the energy causing expansion. Heat quantity thermodynamically designated as Q serves two purposes, namely, (1) latent heat of expansion, (2) heat of temperature rise. The liquid and vapor states are continuous, and latent heat of vaporization is embraced within the broader term latent heat of expansion. Thus, it is true that on heat addition a liquid will pass into a vapor without change of temperature during the process, but it is also equally true that this vapor will further expand on further heat addition without change of temperature.

For both vaporization and subsequent vapor expansion under the above conditions of constant pressure and constant temperature, heat will be absorbed. Under such constant temperature and pressure conditions there would be no abrupt change in the rate of expansion from the liquid to the vapor states, as the change would be uniform and gradual. A new significance can therefore be attached to latent heat if latent heat of expansion be used to replace the less comprehensive term latent heat of vaporisation.

As has been stated, heat serves two purposes, one of which is to cause expansion, the other to increase the temperature. To increase the pressure on the walls of confining space of constant volume heat must cause a temperature rise. An increase of pressure invariably increases the boiling point of a liquid and decreases the latent heat required for vaporization. At a point very near to the critical pressure the latent heat required for vaporization is said to equal zero. What actually takes place can be visualized by imagining a unit volume of liquid expanding in a confined space sufficient to take care of the liquid expansion at equilibrium vapor pressure until the critical presure is reached. The temperature would increase with the pressure, a quantity of heat would be absorbed for this temperature rise. The liquid would also expand but the volume change would be small as compared to that of change of state from liquid to vapor or that of gas expansion. At the critical point, the temperature, pressures and volumes are characteristic of substance. The symbols for these constants are Pc, Vc and Tc. The critical constants are among the most valuable indices to the behavior of a substance or physical change. On a mol-unit basis the expression

$$\frac{PcVc}{RTc}$$

is approximately the same for all substances, a rather striking fact since Pc, Vc and Tc singly are never the same for any substance.

TABLE NUMBER 1
Critical Values of Some Hydrocarbons

Name	Formula	Pc lb. /sq."	Vc cu. ft.	Tc°F	dc	Mol. Wt.
Methane	CH_4	675	1.58	—116	0.1615	16.03
Ethane	C_2H_6	710	2.18	+ 90	0.220	30.05
Propane	C_3H_8	666	3.08	207	0.229	44.07
Isobtane	C_4H_{10}	538	3.95	273	0.234	58.08
Butane	C_4H_{10}	552	4.03	309	0.232	58.08
Isopentane	C_5H_{12}	485	4.92	370	0.2343	72.10
Pentane	C_5H_{12}	487	4.97	388	0.2323	72.10
Diisopropyl	C_6H_{14}	452	5.74	442	0.2411	86.12
Hexane	C_6H_{14}	436	5.86	455	0.2344	86.12
Cyclohexane	C_6H_{12}	597	5.00	538	0.2703	84.11

Pc=critical pressure lbs./sq. in. abs.
Tc=critical temperature °F.
Vc=critical volume 1 lb. mol in cu. ft.
Vd=critical density basis water=1.

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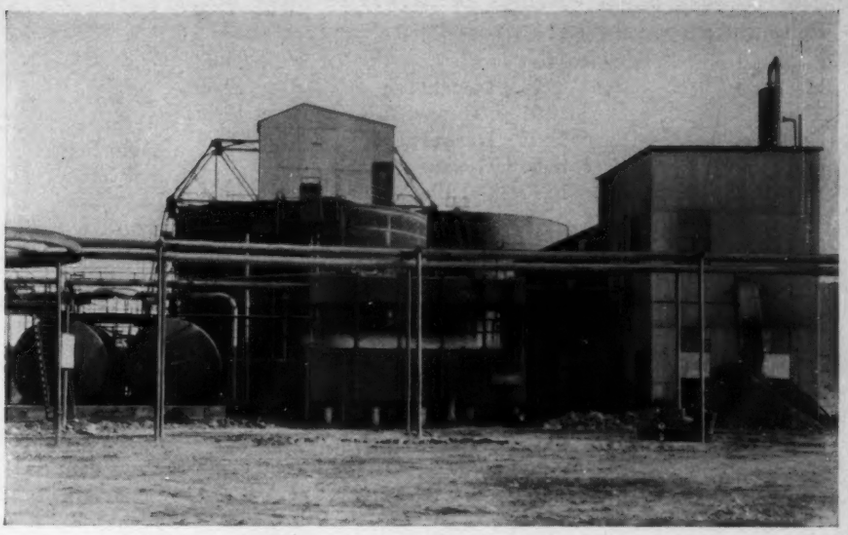

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gas laws the molal volumes at critical pressure and temperature would be:

	Cubic Feet		Cubic Feet
Methane	5.84	Isopentane	19.65
Ethane	8.91	Pentane	19.96
Propane	11.45	Diisopropyl	22.90
Isobutane	15.66	Hexane	24.10
Butane	16.40	Cyclohexane	19.15

Comparison of the above values with those of Table No. 1 under Vc show that at least for the critical pressure and temperature Boyles and Charles Laws do not apply. The critical temperature is the temperature at which no amount of pressure will cause the substance to change from the gas to the liquid state. The critical point may be considered as the beginning of equilibrium conditions between the vapor and liquid states for at all lower temperatures a pressure corresponding to the vapor pressure will cause liquefaction. If the pressure is kept constant at that for the critical and the temperature raised the gas will expand to a point where Boyles Law will hold. For all intermediate temperatures the volume will be less than that of a perfect gas. Holding the temperature constant as that of the critical temperature and reducing the pressure, another point also will be found where the gas laws hold but for all intermediate points on this isotherm, the values will be less than the pv values for a perfect gas. Similarly the volume may be held constant and the pressure raised by raising the temperature to point where the gas laws hold. The critical point may therefore be taken as a logical point for predicting the pressure, volume, temperature relationships.

VAN DER WAALS EQUATION

Van der Waals equation gives much better predictions as to the compressibility of gases in general. This equation has never found much favor by the engineering profession as it is cumbersome and difficult of solution. This equation is written

$$(P + \frac{a}{v^2})$$

(v—b)= a constant. The values of a and b are taken as characteristics of each substance. A is the gas cohesion pressure constant and b is taken as 4 times that of the hypothetical molecules. These values can be obtained from the equations:

$$a = \frac{27\,T_c^2}{Pc \times 273^2 \times 64}; \quad b = \frac{Tc}{273 \times 8\,pc}$$

where Tc=critical Temperature °C abs. and pc= critical pressure in atmospheres. The writer has calculated the a and b values given below from the corresponding critical temperatures and pressures given in Table Number 1 by use of the above equations.

TABLE NUMBER 2

Van der Waals Constants for Hydrocarbons

Name	a	b	$\frac{(1+a)}{(1-b)}$
Methane	0.00452	0.00191	1.0026
Ethane	0.0109	0.00290	1.0080
Propane	0.0172	0.00466	1.0125
Isobutane	0.0255	0.00509	1.0203
Butane	0.0275	0.00522	1.0221
Isopentane	0.0366	0.00643	1.0299
Pentane	0.0377	0.00652	1.0309
Diisopropyl	0.0463	0.00748	1.0385
Hexane	0.0493	0.00787	1.0410
Cyclohexane	0.0428	0.00625	1.0363

Various values of p can now be found by substituting arbitrary values for v in the Van der Waals equation in the form

$$p = \left(\frac{(1+a)\ (1-b) \times T\ Fabs.}{(v-b) \times 492} \right) - \frac{a}{V_2}$$

This equation is based on a volume = 1 at 1 atmosphere absolute and 32° F. For example ethane (refer to Table No. 2) at ½ v would have a pressure at 60° F.

$$p = \left(\frac{(1+0.0109)\ (1-0.00290) \times 520}{(.5-0.00290) \times 492} \right) - \frac{0.0109}{(.5)^2} = 2.11 \text{ atmospheres.}$$

By Boyles and Charles laws $p = 2 \times \frac{520}{492} = 2.12$ atm. The deviation becomes greater as the pressure increases. The higher members of the series vary more than ethane so it is at once evident that the assumption that the gas laws hold for high stage compression and high pressure fractionation leads to serious errors. The deviation from a perfect gas becomes greater the heavier the hydrocarbons and the higher the pressure up to a certain limit.

Thus for butane under the above conditions

$$p = \frac{1.0221 \times 520}{492\ (0.5-0.00522)} - \frac{0.0275}{(0.5)^2} = 2.072 \text{ atm.}$$

or if the volume is reduced to 1/10 the equation is

$$p = \frac{1.0221 \times 520}{492\ (.1-0.00522)} - \frac{0.0275}{(0.1)^2} = 8.6 \text{ atm.}$$

which by Boyles law would be $\frac{10 \times 520}{492} = 10.55$ atm. which is 21.8 per cent greater than the more correct value of 8.66 atmospheres. PV curves can be plotted from the calculated values found by substituting various volumes and temperatures as shown above. The pressure-volume curves will represent

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the actual experimental results rather closely more so than those ordinarily used.

THE DIETERICI EQUATION

The Dieterici equation of state which is in reality a modification and improvement over the Van der Waals equation yields results that are very close to the experimental. The excellent agreement between calculated and observed values by this equation is shown by $\frac{RTc}{PaVc} = \frac{1}{2} c^2 = 3.695$ whereas the mean observed value of all substances so far examined is very nearly 3.7. In the above equation R = molecular gas constant, and e is the base of natural logarithms = 2.7183. This is rather interesting as e is a purely mathematical constant of a universal nature. The equation of state is written

$$p = \frac{RTc}{V - \frac{1}{2} Vc} \left(2.7183 \right)^{-\frac{2Vc}{V}}$$

Where pressure, volume, critical pressures and critical volumes are known from experimental values for a substance the value of the constant R can be determined. The R constant has a wide application in other equations of state involving specific heats and latent heats of expansion and vaporization. Both Van der Waals and Dietrici's equations have their limitations but in general both give remarkably close results concerning their very general nature. As far as can be found the ultimate volume to which molecules can be compressed is 0.26 Vc whereas Van der Waals at this point of greatest density is 0.33 Vc and Dieterici's is 0:5 Vc. These values of course are those at extremely high pressures. For pressures and temperatures within the realm of present industrial application both suffice to a great extent. For pressures up to 600 pounds Dieterici's equation can be used to advantage and above this Van der Waals up to 2500 or 3000 pounds, after which experimentally determined figures must be used for the hydrocarbon gases.

ISOTHERMS, ISOBARS AND ISOCHORES

If the temperature is held constant and the pressures and volume varied the volume being plotted on the ordinate and the abscissa (see Chart Number 1) the curve defined by the intersection of abscissas and ordinates is the isotherm. In the accompanying chart the constant temperature is the critical temperature of isopentane and the volumes are found by dividing the actual volume by the critical volume. This gives the critical isotherm.

If the pressure is held constant and the volume and temperature varied and the result plotted as described under the isotherm, the line so defined will be an isobar. Similarly, if the volume is held constant and temperature and pressure varied, the resultant line will be an isochore. The line of constant pressure at that of the critical pressure is the critical isobar and so with the critical volume as a constant, the critical isochore will be formed. The critical isotherms, isobars and isochores are by far the most valuable indices to the thermodynamic properties of gases and liquids and for this reason from a sound basis of comparison for all pressure-volume-temperature relationships. For every temperature there is an isotherm, similarly for every pressure there is an isobar and likewise for every volume, an isochore. The isotherms, isobars and isochores of the hydrocarbons of natural gas will be presented in a subsequent article dealing more specifically with those very interesting and valuable characteristics.

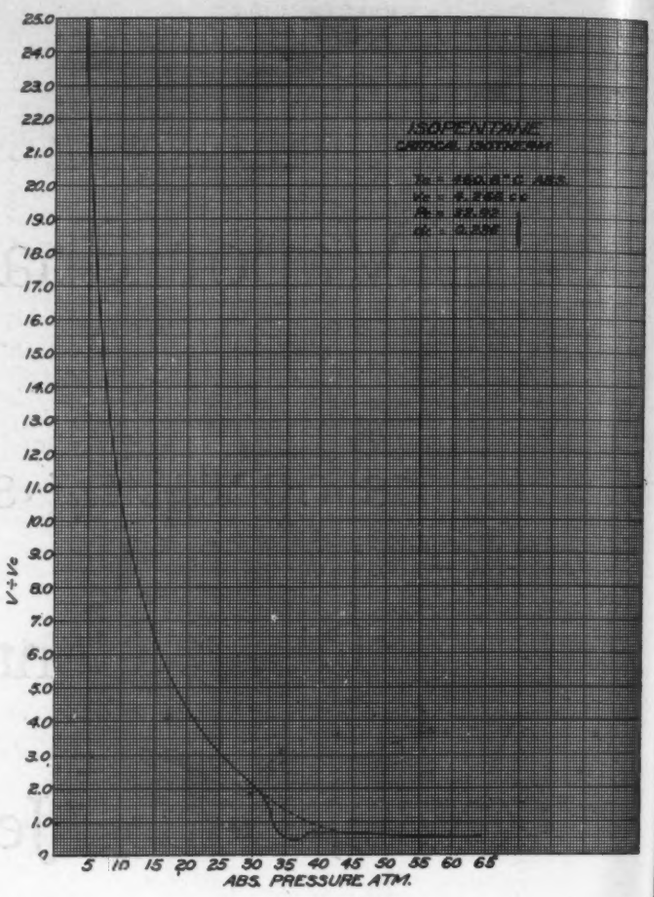
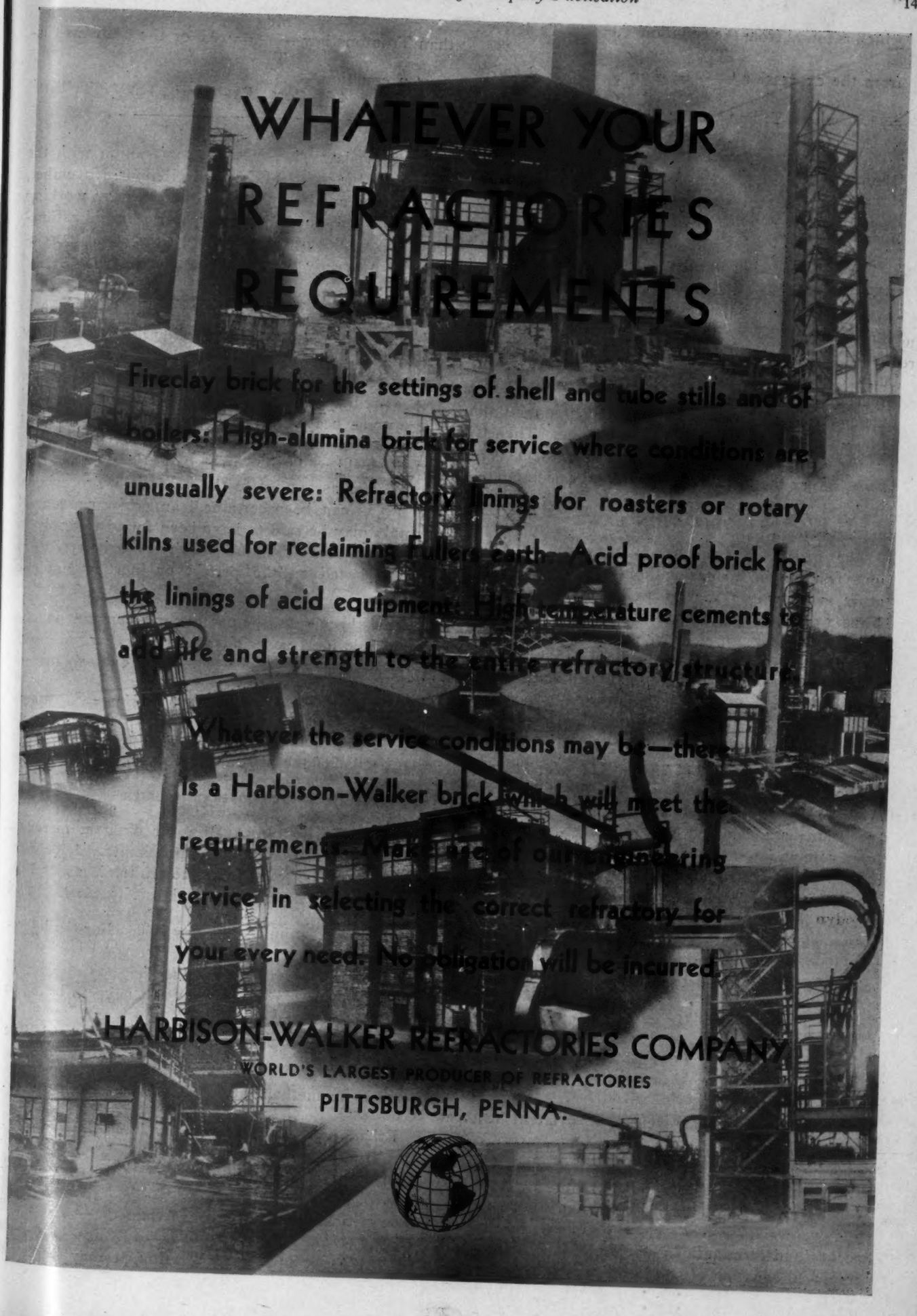


CHART NO. 1

THE (PV) P DIAGRAM

An isothermal can be drawn by plotting the (PV) values against the pressure (P) values. If P is taken at some initial volume as one and V as one, then, according to Boyles law, every product of pressure times volume equals one, thus, $P_1V_1 = P_2V_2 = P_3V_3$, etc. For all gases and particularly the hydrocarbons (see Chart Number 1) this assumption is far from true. For each temperature isothermal there is a point of minimum pv or of maximum compressibility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which is found from the equation $T_1 = 2.98$ Tc derived from the expression $\frac{T_1^n}{T_c^n} = 4$ or $\sqrt[n]{4} = 2.98$ and n $= 1.27$ where T_1 and Tc are in degrees absolute.

TABLE NUMBER 3

Methane	565°F	Isopentane	2010°F
Ethane	1178°F	Pentane	2076°F
Propane	1530°F	Diisopropyl	2227°F
Isobutane	1723°F	Hexane	2275°F
Butane	1831°F	Cyclohexane	2520°F

It will be noted in the above Table 3 that the value of T is well within the range of decomposition of the hydrocarbons with the exception of methane and to some extent ethane. The significance of the temperature T_1 is in the fact that they denote the temperature for which some system having the carbon-hydrogen ratio of the pure component will be by extreme pressure reduced to an irreducible minimum volume probably napthene and methane. Then T_1, in the case of hexane, refers to the system $(C_6—H_{14})_n$ rather than C_2H_6 etc. for the other compounds.

VAPORIZATION LAWS

That heat which goes to produce a change of volume from liquid to gas without change of temperature is known as the latent heat of vaporization. Thus a pure compound such as pentane will boil at atmospheric pressure or other constant pressure changing completely from the liquid to vapor state without change of temperature, or in other words, at constant boiling point. Thus the only variable is that of volume as both temperature and pressure are constant. By thermodynamics any heat quantity is designated as Q so if the quantity Q for the changes of volumes from liquid to vapor are known and the volume of vapor, a QV curve can be drawn. This need not be considered to stop when vaporization is complete as for each increase of volume of the vapor at constant pressure and temperature will require the addition of heat. Nernst (Application of Thermodynamics to Chemistry, P. 103) has given a formula whereby the heat of vaporization may be determined with an accuracy that can be said to exceed that of experimental determination. This equation is:

$$Mr = Q$$

$$Q = R \frac{T_1 T_2}{T_1 — T_2} \left(1 - \frac{P}{P_c} \right) \log \frac{P_1}{P_2}$$

where M = molecular weight, R = latent heat per pound vaporized, T_1 = a vapor temperature corresponding to vapor pressure p_1, T_2 = a vapor temperature corresponding to vapor pressure p_2, R = universal gas constant = 1.985, p = any pressure. T_1 and T_2 are taken very close together. For rigidly accurate determinations of Mr, this Nernst semi-empirical equation of state gives much better results than Troutons law $\frac{Mr}{T} = 20.3$ or the Clausius-Clapeyron equation,—

$$Mr = \frac{4.57 \ (\log_{10} P_2 - \log_{10} P_1) \times T_1 T_2}{(T_2 - T_1)}$$

Troutons law when used in conjunction with the Hildebrand function (I. N. Beall, Refiner, November, 1930) gives good results over the ordinary working conditions and is good for purposes of rapid estimation. Examples of calculations by the Clausius relation have already been given in previous articles.

SPECIFIC HEATS

The value of the ratio of specific heat Cp and Cv as an index to the compression curve has already been discussed. General equations of state applicable to the prediction and calculation of specific heats and the specific heat ratio k or gamma are conspicuous by their absence. For this reason the writer has devoted considerable time to that very important subject insofar as applies to the gaseous hydrocarbons. As far as can be ascertained, an arbitrary general formula may be said to have been found to apply to the specific heat ratio for the hydrocarbons and in general based on the perfect or inert monatomic gases.

As has been seen, the gamma or k constant for the monatomic inert gases such as helium, argon, neon, krypton, mercury, etc., is 1.667. By the purely mathematical relation $\frac{n+1.5}{n+0.5} = 1.667$ so, if n = 1 represents the number of atoms in the molecule, the equation is that of the specific heat ratio. For the diatomic gases n=2, the equation becomes $\frac{2+1.5}{2+0.5} = 1.40$. Now all the diatomic gases, air oxygen, nitrogen, hydriodic gas, give values approximately 1.40. Similarly it will be found that the triatomic gases NO_2 and H_2S give experimental values $NO_2 = 1.27$, $H_2S = 1.33$. The formula $\frac{3+1.5}{3+0.5} = 1.286$. For the hydrocarbon gases beginning with methane (CH_4) it will be found that two hydrogens will have to be taken as 1 so the formula $\frac{n+1.5}{n+0.5} = 1.286$ will hold. The $\frac{Cp}{Cv}$ ratio for methane at 68°F. is 1.286 experimentally.

Ethane C_2H_6 is an 8 atom gas but considering 2H = 1 atom, 5 is used in the formula $\frac{5+1.5}{5+0.5} = 1.182$. The critical temperature of methane is — 116°F and that of ethane 90°F. 257 — 90 = 167°F; — 116 — 68 = 184°F so, as a generalization, it may be stated

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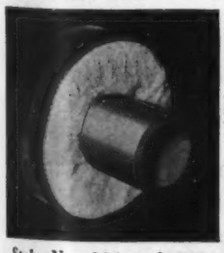

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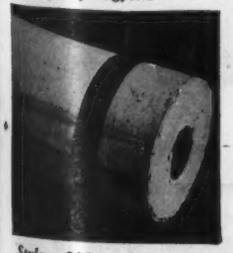

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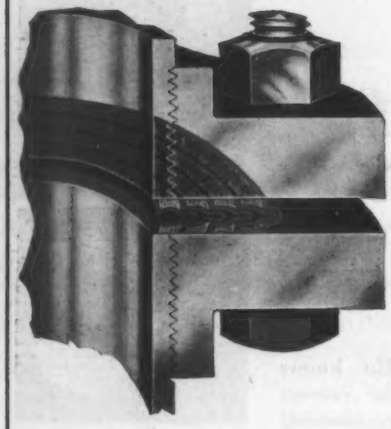

● **Loosen the bolts that hold a flexitallic Gasket in place and *the Gasket expands.* It's not a flattened, lifeless, useless thing; it's a revived, re-useable piece of equipment.**

● **Look at the picture; note the SHAPE of the metal — the interlocking V's. Around and around, in a continuous spiral, they dove-tail. Now pull down a bit with the Flexitallic Gasket in place. Picture the V-shaped metal pushing like a spring against the squeeze. Picture the tightness of the seal.**

Again release your bolts. Picture the comeback; the re-useability; the wisdom of your small Flexitallic investment.

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that for temperatures equally removed from the critical, the formula holds within the limits of experimental error, the variation being less than .05 in the second decimal place. Going up the hydrocarbon series C_nH_{2n+2} the numerical relation on the foregoing basis is 3, 5, 7, 9, 11 for values of N corresponding to ethane, methane, propane, etc. respectively. The y values are:

TABLE NUMBER 4

Name	Formula	N	y calc.	y obs.	Temp. of ° of y obs.
Methane	CH_4	3	1.286	1.286	20
Ethane	C_2H_6	5	1.182	1.182	125
Propane	C_3H_8	7	1.132	1.130	...
Isobutane	C_4H_{10}	9	1.105	1.11	80
Pentane	C_5H_{12}	11	1.087	1.09	...
Hexane	C_6H_{14}	13	1.074	1.08	...

Apparently for ordinary temperatures the rule seems to hold with reasonable accuracy for the chemically saturated hydrocarbons. Jankowsky (Z. Elektrochem. 23, 368 — 71 (1917), gives the formulas:

$$K = \frac{Cp}{Cv} \quad K = 1 + \frac{2C}{3Cv} \quad \text{and} \quad K = \frac{1}{1 - \frac{2C}{3Cp}}$$

where $C = \sqrt[1.27]{4} = 2.98$ and Cv and Cp refer respectively to the molecular specific heats at constant volume and constant pressure. It is thus possible, providing this equation holds, to calculate Cv for every value of Cp at various temperatures and pressures and likewise the value of k, or exponent of the adiabatic compression curve. As the Cp values are relatively easy to determine experimentally, the equation should be of value. Additional equations of state of practical and theoretical interest to the industry will be presented with curves and charts to date to simplify calculations in a subsequent article.

Phillips Pipe Line Company filed its first tariff with the Interstate Commerce Commission, issued March 12 and effective March 16. The basic rate is 70.5 cents a barrel on gasoline from Borger, Texas, to Wichita, Kansas. The tariff provides for a refund of part of that rate if and when gasoline is shipped out of Wichita within 12 months. The refund is to be made to the basis of a rate of 28 cents a barrel from Borger to Wichita if the gasoline goes, even by truck, to Oklahoma and Kansas points.

When reshipped to points beyond those states the refund is to be to a basis ranging from 28 to 67 cents for the pipe line haul to Wichita.

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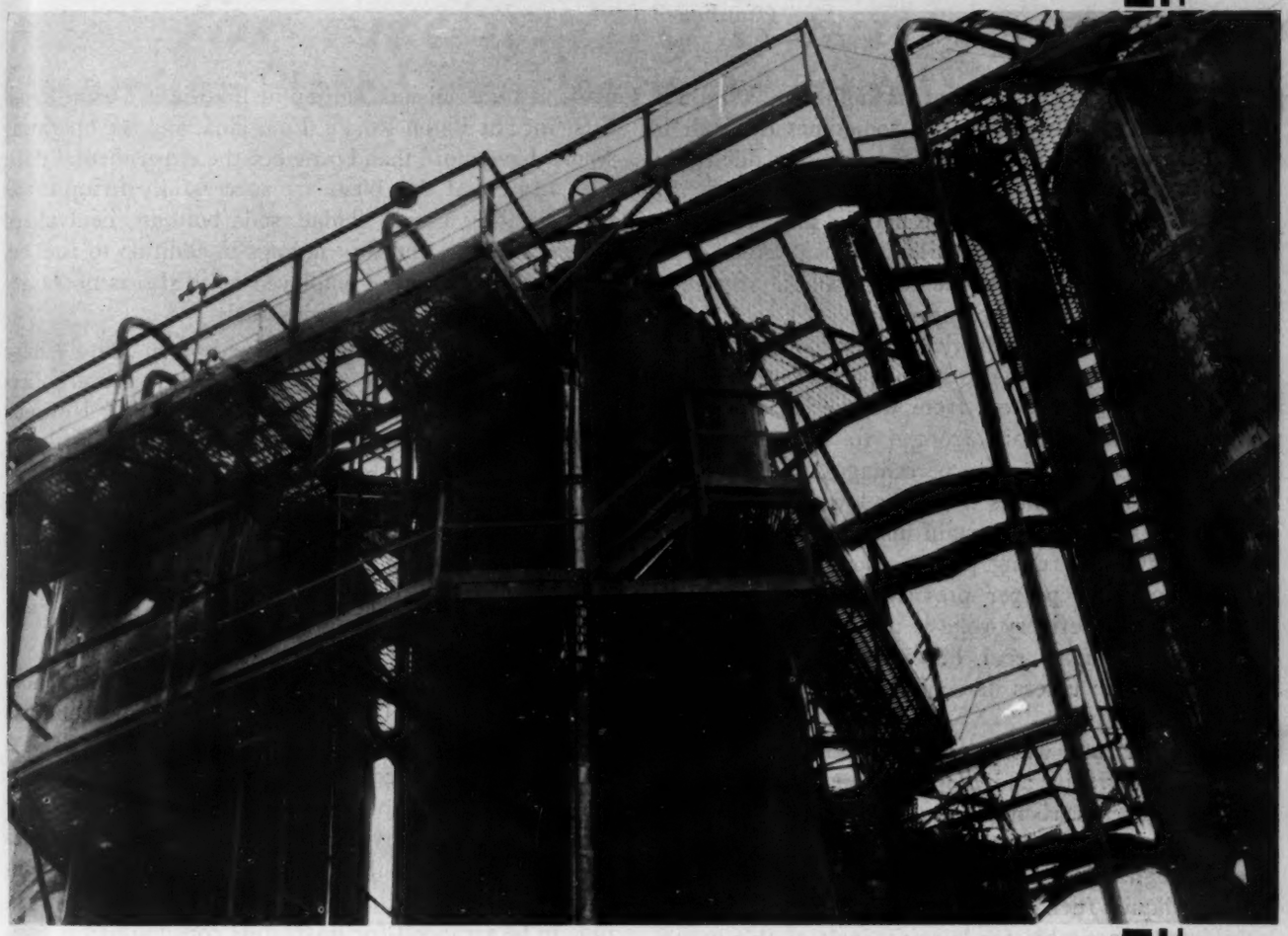

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Burners for Firing Waste Fuels

(*Continued from page 76*)

a heat content per cubic foot as high as 2200 B.t.u. When burning these gases it is sometimes difficult to obtain the best appearing furnace conditions, due to the presence of a large percentage of the heavier hydrocarbons, and also because there may be present considerable quantities of raw distillate in suspension. Of course, whenever possible the raw distillate should be properly removed in a separator.

Among the waste pulverized fuels being fired by these burners are various forms of petroleum coke. Depending upon the process from which this material is derived, it may contain from 4 to 12 per cent of volatile matter, and varying percentages of sulphur and ash. The ash content is normally low, and its fusing point high, although in certain instances fuels containing ash having a fusing point as low as 2000°F. are encountered, and proper provision must be made to handle these. Refinery coke is often less friable than ordinary bituminous coal, but it is burned readily in pulverized form unless its composition approaches that of a pitch.

The liquid fuels which are encountered often are of high specific gravity and contain a considerable amount of solid matter, carbonaceous or otherwise, in non-colloidal suspension. Mechanical atomization long has been recognized as the most economical method of burning liquid fuel, but not until recently has it been considered practicable for burning fuels of this nature.

Apparently one of the reasons for the previous inability to handle acid sludge in particular, and refinery sludges in general, in mechanical atomizers, was because capacity control by the use of inlet pressure variation was employed. Furthermore, it had been taken for granted that the mechanical atomizer must handle the fuel under exactly the same conditions as the steam atomizer and due to the high standard of operation expected from the mechanical atomizer it was at the same time required to produce far better results before being considered successful.

The wide range mechanical atomizer of the circulating type requires no supply pressure variation and its capacity can be controlled throughout a wide range without destroying the spray. With fuels containing suspended matter more fuel than is sprayed into the furnace can be circulated through the atomizer. This gives high velocity, eliminates dead ends and precipitation, and cools the tip; in short, it prevents carbonization and plugging.

Extensive tests indicated that with a little preparation refinery sludges could be burned satisfactorily in the Wide Range mechanical atomizer of the circulating type. As a result of these tests, an installation was made at the Louisiana station of Louisiana Steam Products, Inc., at Baton Rouge, Louisiana, and the operating results have more than borne out the experimental data. The burners at this plant are successfully firing crude or lubricating (acid) sludge, soda bottoms, neutralized sludge, acid tar, and wax tailings in addition to fuel oil. Combined burners are employed as it also is necessary to fire pulverized and gaseous fuels.

Combined burners of the type shown in Plate 4 have been purchased to fire two 600 pound pressure boilers at the new steam station of the Humble Oil & Refining Company at Baytown, Texas. Each burner will fire approximately 4000 pounds per hour of fuel oil and each boiler is to produce 350,000 pounds of steam per hour. In addition to oil, there will be burned various refinery sludges and natural gas.

SLUDGES AS FUEL

An example of a station in operation where various waste fuels are used to full advantage is the Louisiana station. There combined burners similar to Plates 2 and 4 are firing successfully various kinds of refinery sludges, petroleum coke, natural gas, and fuel oil, under four boilers each having a capacity of 350,000 pounds of steam per hour, the boiler feed being treated Mississippi River. As this station is the first of its magnitude to be arranged for waste fuel consumption in combined burners, its design and operation are of great interest to combustion engineers, and without discussion of its fuel problems this paper would be incomplete.

The proportion of the heat supplied by the different fuels varies considerably but averages about as follows, the fuel oil, which is used only for standby purposes, being neglected: 50 per cent natural gas, 33 1/3 per cent refinery sludges and 16 2/3 per cent petroleum coke. About 85 per cent of the sludges contain from 30 to 50 per cent of dilute sulphuric acid which gives them an actual acid content of about 12 to 20 per cent. Approximately one-half of the remaining 15 per cent of the sludges is strongly alkaline.

Some of the sludges fired at Louisiana are more or less readily "burnable" but lubricating (acid) sludge, proper, had in many cases caused considerable difficulty and the equipment heretofore developed in the refineries for burning it has been designed primarily for the purpose of disposing of the fuel and not with the main object in view of obtaining efficient combustion. The combustion of the sludge usually has been the most convenient means of disposal and the mere ability to burn it has been considered an event.

This sludge is extremely variable in its characteristics,

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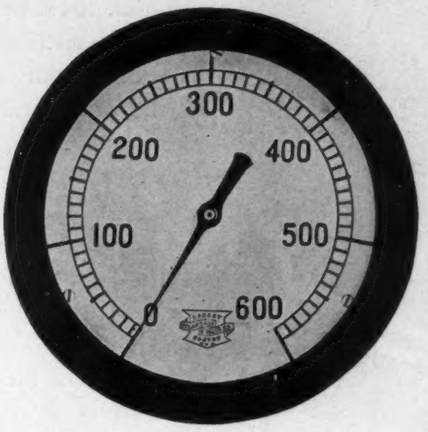

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depending not only upon the initial crude stock but also upon the method of treating of that stock, including the amount and type of oil used for fluxing, as well as the method of agitating the flux with the sludge. Sludge often contains a large amount of suspended carbonaceous material, and one acid sludge may be practically

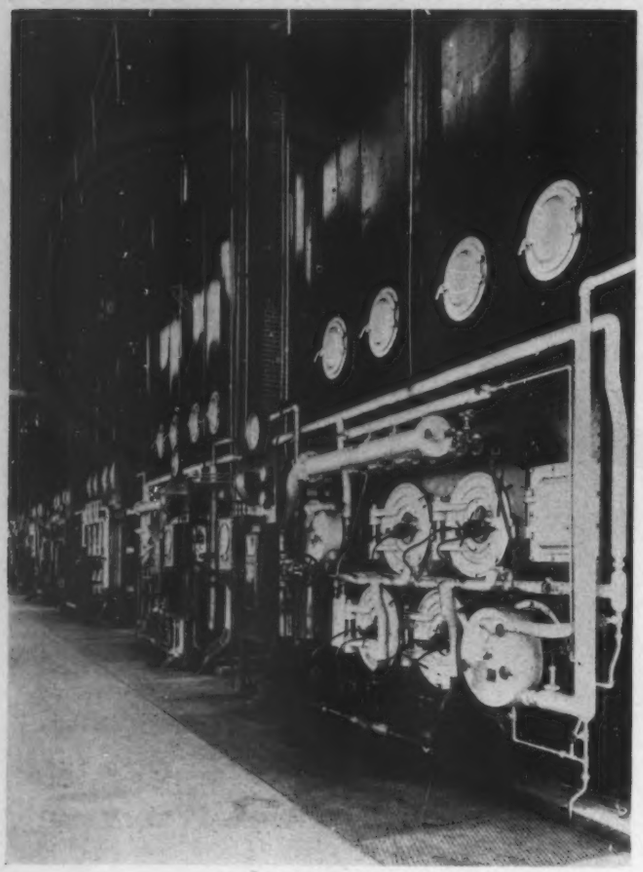


PLATE 6

solid and another rather fluid. It varies from day to day and from hour to hour. Some sludges have a heat content as high as 17,500 B.t.u. per pound, whereas others have a heating value as low as 8000 B.t.u. per pound. This wide variation is accounted for largely by differences in the amount of flux which must be added to make the material flow, and by variations in the weak acid content. This latter often will run as high as 40 per cent. One sample of acid tar (which is considerably more fluid than the acid sludge) contained 54 per cent weak acid, i.e., acid and water, of which 38 per cent represented the acidity, which means that the tar contained 21 per cent of actual sulphuric acid.

The gravity of acid sludge may run from 5 to 14° Be. The viscosity of the material cannot be determined, as the heavy and light components settle out in the viscosimeter, giving readings which are not at all representative of the true internal friction.

Lubricating acid sludge usually must be treated. This treatment ordinarily consists of fluxing with oil or tar to reduce its viscosity. Sometimes a sludge cannot be made "burnable" by fluxing in this fashion and must have a caustic material added to it. This process changes it from acid to neutralized sludge. The proper viscosity cannot always be obtained by additional heating, as some sludges tend to foam at a temperature slightly above 200°F.

Sludges usually are kept in agitation in suitable lead or brick-lined tanks by jets of steam or jets of steam and air. Quite possibly some method of mechanical agitation could be used instead of steam, but up to the present time this has not been done. In some plants it has been found impracticable to use tank heating coils as the sludge carbonizes on the outside of the coils, reducing the heat transfer. Furthermore, agitation such as is now accomplished by steam jets seems desirable.

The preparation of the sludge varies with its character and differs in many refineries. No definite rules can be laid down for its treatment. As to whether or not it is properly fluxed or sufficiently agitated, only visual observation of experienced operators can determine. About the only definite statement which can be made about it is that a properly prepared sludge will be smooth and not too granular.

Improper treatment will cause coking. Any coke particles which are precipitated from the sludge tend to coagulate and form larger lumps of coke. In firing boilers with acid sludge or acid tar, it is necessary to keep the exit gas temperatures above the dew point in order to prevent acid corrosion of the flues and certain portions of the heating surface. At Louisiana no acid fuels are burned when the boiler capacity falls below a value giving a final gas temperature below 275°F. However, in the case of air preheaters where there are any dead pockets or points in which a local cooling effect may be obtained, there is a strong possibility even then that some corrosion will occur. With

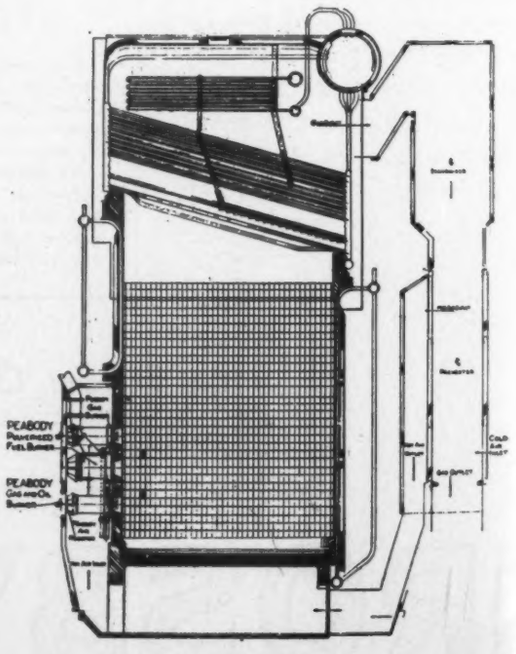
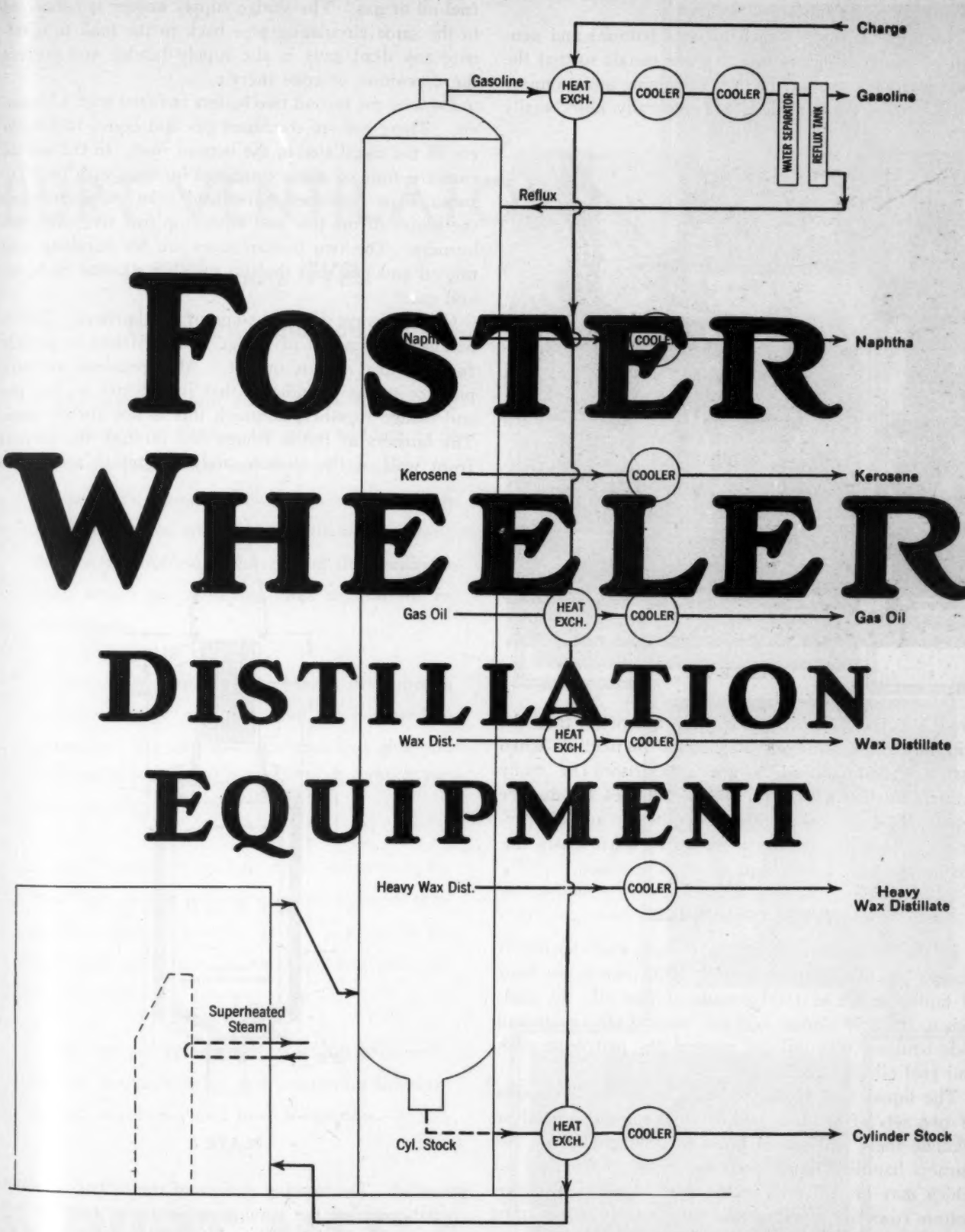


PLATE 5

FOSTER WHEELER DISTILLATION EQUIPMENT



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some sludges slag is deposited on the furnace bottom and on the boiler tubes.

The alkaline sludges such as soda bottoms and neutralized sludge do not attack ferrous metals so that the usual materials are satisfactory for piping and atomizer parts. Also, these sludges are generally more easily

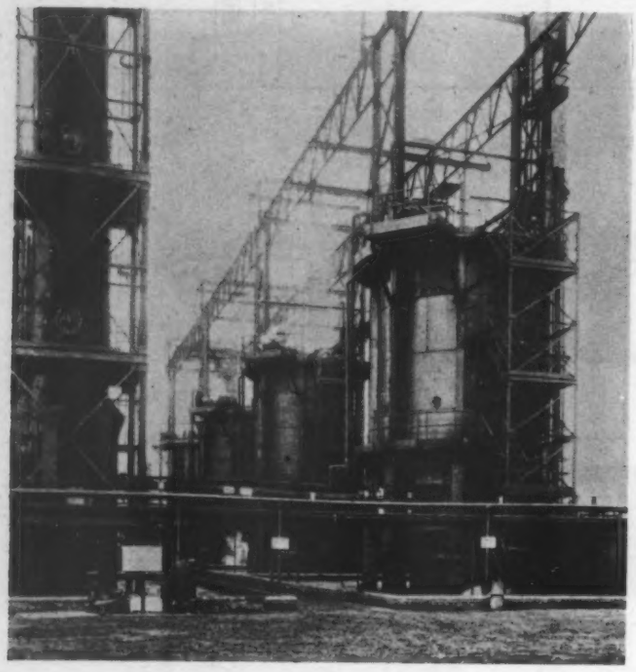

PLATE 7

fired, and less variable in their characteristics than the acid lubricating sludge. Brickwork difficulties when burning alkaline sludges are experienced in many plants. Furthermore, with alkaline sludges salt may be deposited on the boiler tubes, superheater and air preheater. This may result in excessive draft losses unless ample soot blowing equipment is provided.

TYPES OF BURNERS

In the installation at Baton Rouge, each burner is designed to handle approximately 2700 pounds per hour of liquid sludge of 1600 pounds of fuel oil. In addition to the acid sludge, acid tar, neutralized sludge and soda bottoms, wax tailings, natural gas, petroleum coke and fuel oil also are burned.

The liquid fuel piping on each boiler front consists of two sets of headers, one of steel for the neutral or alkaline fuels, and one of brass for the acid fuels. All burners handling liquid fuels are piped to fire fuel oil which may be delivered in the steel header. The two bottom rows are piped to take their supply either from the acid or alkaline header, while the top row takes its supply from the alkaline header only. Each burner is equipped to fire gas.

Each of two of the four boilers is equipped with 18 combined gas and liquid fuel burners in three horizontal rows of six each. The two bottom rows of burners handle acid sludge. The top row handles neutral or alkaline fuels. All burners, of course, can be used for fuel oil or gas. The sludge supply header is connected to the same circulating pipe back to the tank to eliminate any dead ends in the supply header and prevent the deposition of coke therein.

Each of the second two boilers is fitted with 17 burners. There are six combined gas and liquid fuel burners of the usual size in the bottom row. In the second row are four of these combined burners with two Toronto Type combined pulverized coke gas burners in the center of the row and in the top row five combined burners. The two bottom rows are for handling acid tar, oil and gas, and the top row for alkaline fuels, oil and gas.

Gas is always fired in some of the burners. This is because the amount of sludge is insufficient to provide for the total steam output. Also previous refinery practice seems to indicate that it is better to fire gas and sludge together, although this is not always done. The burners at Baton Rouge fire through the vertical front wall of the furnace and no ignition arches are

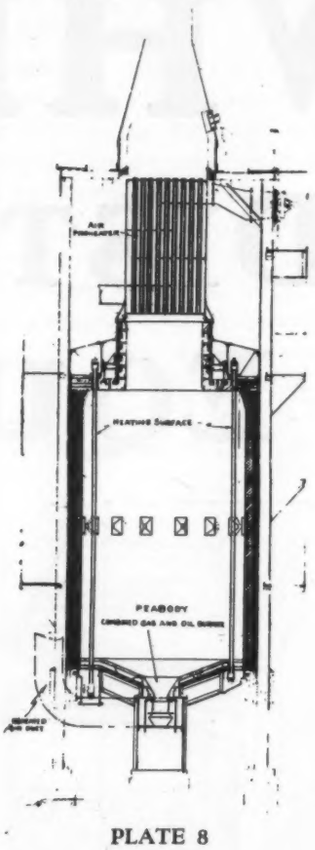

PLATE 8

provided. The interior surface of the furnace is water-cooled, part of the cooling tubes being covered with refractory material. Plate 5 is a sectional view of the furnace.

The question of the ideal material for burner tips has not been settled definitely. The difficulty of this problem will be realized when it is stated that in one plant using steam atomizers brass tips have been eaten away in 48 hours. The tips originally supplied seem to

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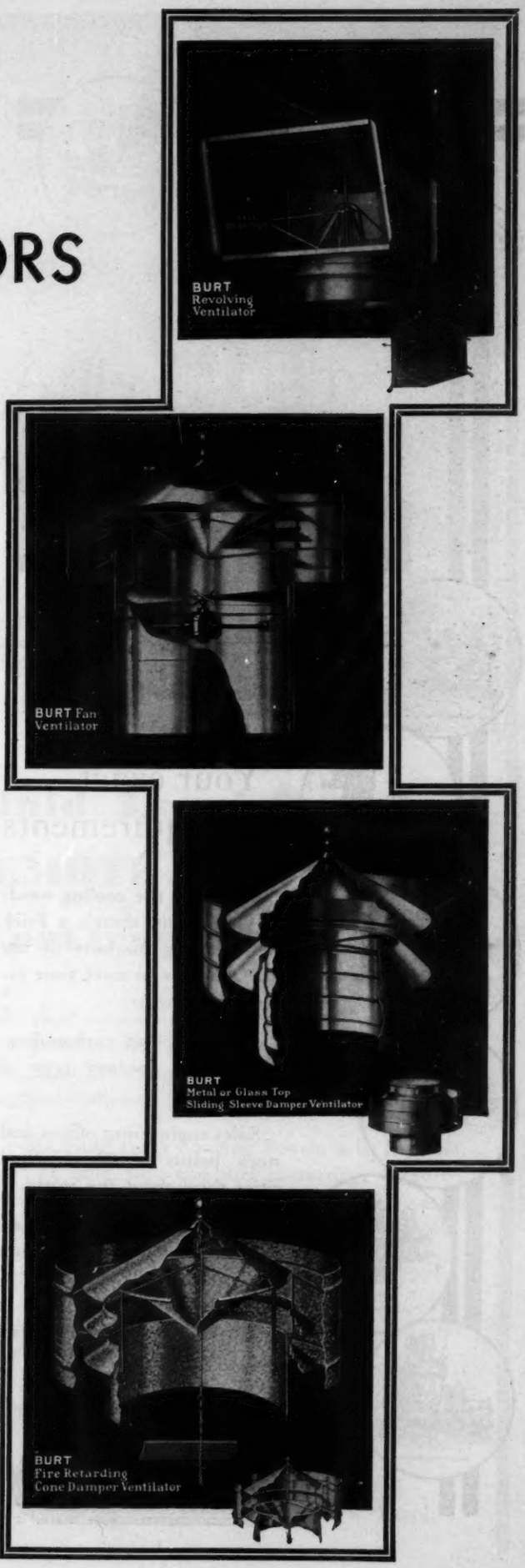

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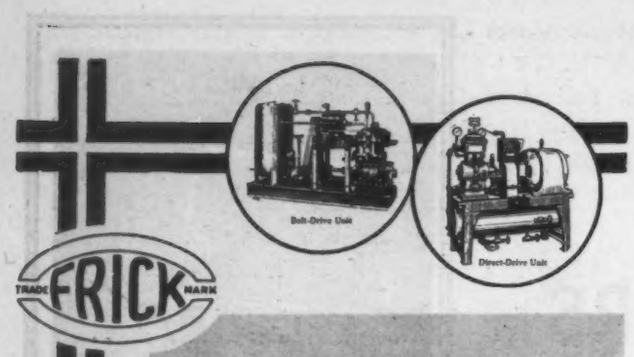
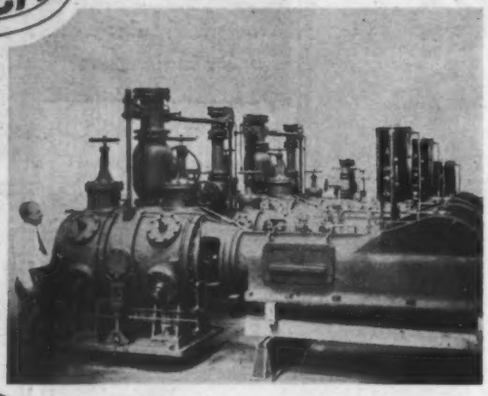
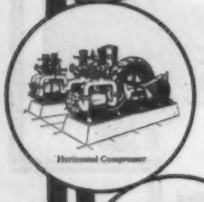




One of the six Frick 2-stage compressors in operation at Cumberland, Md., plant of Celanese Corp. of America.



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have given the best service, although this is not so good as is obtained when firing fuel oil. The burner tips are being used as a convenient "laboratory" in which to test materials for other parts of the plant subject to corrosion.

Combined burners are being used for firing units of various types. Some of the newer types of oil stills are vertical cylinders as large as 25 feet in diameter, the walls being formed by vertical tubes containing the stock to be processed. Some of these are being fired from the bottom and others from the top. The former method is now more widely employed.

Plate 7 is a view of a bank of vertical heaters fired from the top with combined gas and oil burners. Plate 8 is a sectional view of such a furnace fired from the bottom with a single combined still gas and yard oil burner of the type previously described. This burner liberates 40 million B.t.u. per hour. When burning gas two traverses at right angles in a plane perpendicular to the axis and taken at one foot intervals showed no CO and a CO_2 variation from 10.8 to 12 per cent indicating the evenness of furnace conditions and the manner in which this single burner distributes the furnace gases. Plate 9 shows combined gas and oil burners firing a tube still.

The refinery engineers were presented with an enormous problem when they had to dispose of these fuels,

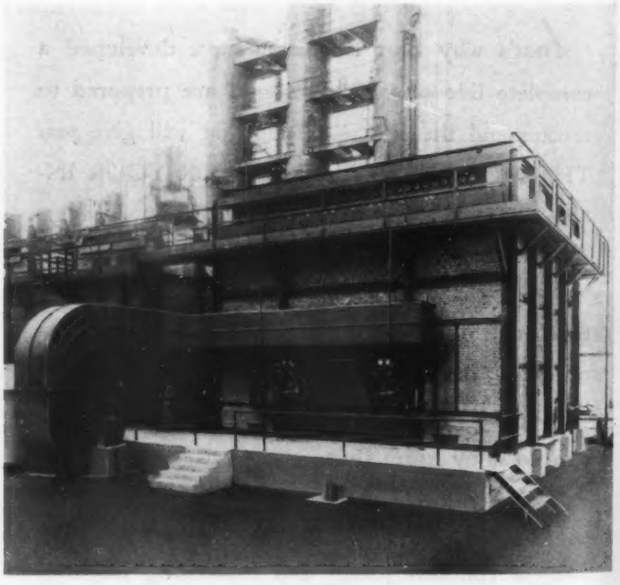
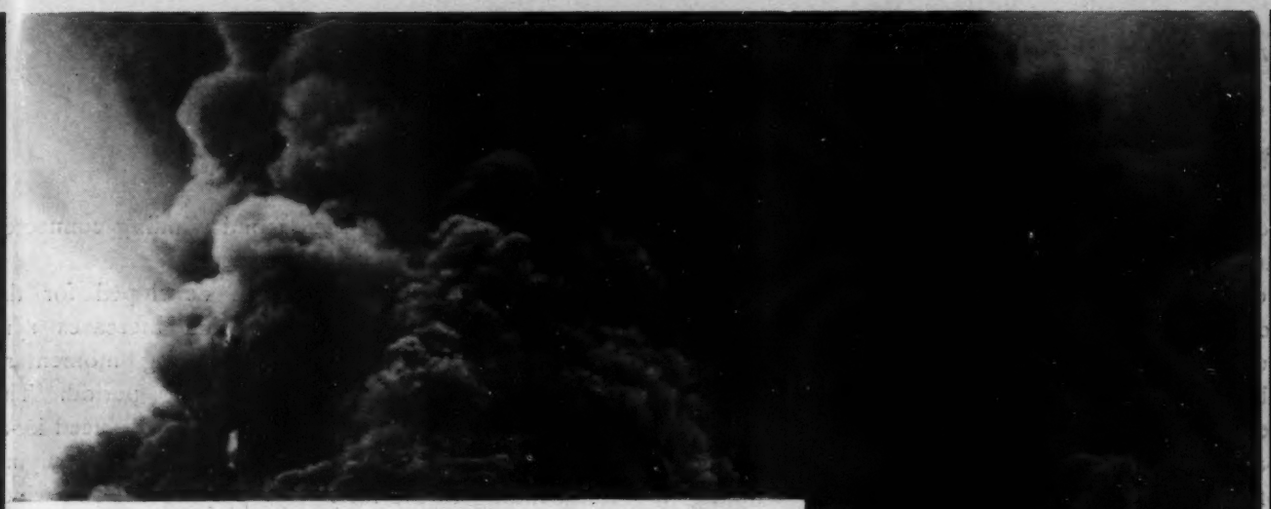


PLATE 9

and the fact that for years they have been burning them is a testimonial to their ingenuity. They have contributed a vast reservoir of information, and if this had not been available, modern installations of waste fuel burning plants would be far behind their present state of progress. No one can have had any contact with the oil refining industry in this country, without developing a profound respect for the intricate problems involved, and the effective manner in which these are being solved.



OIL BLAST KILLS WORKER

Three Tanks and Two Derricks Burn as Fire Perils Entire Santa Fe Springs Field

One man was blown to a fiery death, approximately $150,000 damage was done and the entire Santa Fe Springs oil district was threatened early yesterday when a storage tank of the Getty Oil Company exploded at Butler and Little Lake Roads, Santa Fe Sprmgs.

Ben Best, 38-year-old oil gauger for the Getty company, was dropped into a 1000-barrel-capacity tank of oil—there to meet instant death as a sheet of flame enveloped the tank and his body.

The gauger climbed to the top of the tank shortly after 1 a.m. to measure the amount of oil inside with a steel measuring tape.

He was seen to make his way to the smal aperture atop the huge drum. A few seconds later came the blast—believed by oil men to have been caused by a spark resulting when Best unwounded the metal line.

(Los Angeles Times, Feb. 2, 1931)

Only Fluid Level Gauging By REMOTE CONTROL will wipe out tragedies like this

Experienced field men need no scare talk to impress the utter desirability of switching a perilous hand job to automatic control. And yet, instances like the Santa Fe Springs tragedy speak sad, but powerful, preachments against continuance of the practice.

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Developments in Synchronous Motors

(*Continued from page* 83)

come the disadvantages of reduced voltage starting, line disturbances during starting period. With full voltage reduced kv-a. method of starting, starting torques can be obtained within the range of 52 per cent to 90 per cent of the starting torques obtainable under full voltage conditions. In the full voltage reduced kv-a. starting, motor starting is accompanied by a decrease in kv-a. inrush and a minimum of line disturbances. When the full winding is thrown on, there is no sudden surge because the magnetic circuit of the stator has not been de-energized. In the reduced voltage system there are two large surges one at the starting period and one at the transfer point. In the reduced kv-a. system, the second surge is eliminated and the first is considerably decreased. Figures 2 and 3 show this graphically.

Reduced kv-a. starting permits the use of a simpler starter, eliminating the auto transformer. Less maintenance is required and more dependable starting is obtained.

Many refineries draw electric power from network distribution systems, and in many of these systems the starting current inrush is limited. With full voltage reduced kv-a. starting, it is easily possible to meet the starting requirement of loop distribution systems. In cases where the pull-in torque requirements are low and the current inrush at starting must be limited, the motor can be synchronized on the first winding and the second winding connected after the motor is in synchronism.

New applications have been developed for the frequency responsive relay which increases synchronous motor dependability during momentary power dips and during the starting period. The frequency relay is used in full voltage reduced kv-a. starting where it actuates the switch for applying full winding to the line. By applying the full winding at the proper speed, smooth dependable starting also be used to actuate unloading devices during starting and during operation when motor is pulled out of step. The application will be discussed more fully under unloaders.

DELAYED LOW VOLTAGE RELEASE

There are two methods of obtaining delayed low voltage release, the direct current latching method and the delayed low voltage release push-button. These were designated to minimize interruptions in service due to momentary voltage dips or other line disturbances. While both methods accomplish the desired results, their principles of operation are quite different. In refinery applications of synchronous motors continuity of service is essential, and the use of one of these devices, depending upon the application, therefore is necessary for proper operation.

The time delay under voltage release push-button is for use on applications where it is not necessary to

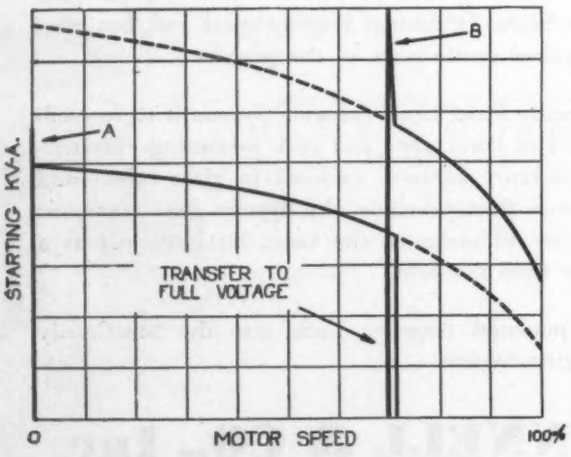


FIGURE 2

Starting Kv-a. curve for reduced voltage starting, using auto transformer. This method of starting causes a large surge of current at starting and transfer, indicated by points A and B. These surges usually cause momentary line disturbances.

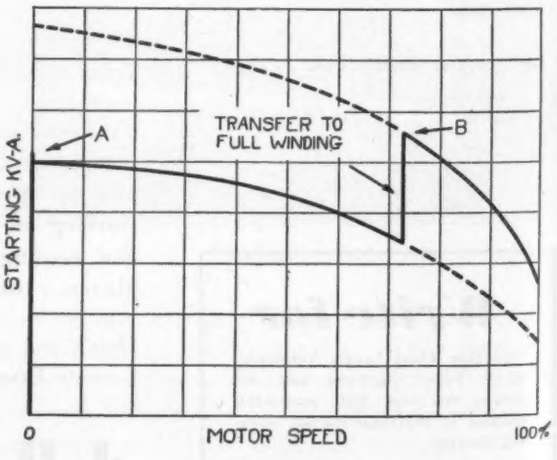


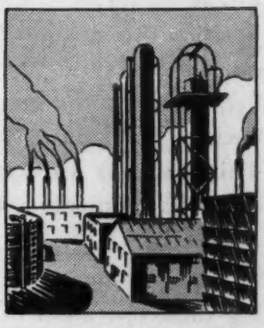
FIGURE 3

Starting Kv-a. curve for full voltage, reduced kv-a. starting using two parallel circuits in the motor. Current surges at starting and at transfer to full winding are eliminated. At transfer, the motor is not disconnected from the line, the Kv-a. simply rises to full winding value without momentary inrush higher than normal.

UNIFORM STRENGTH in Replacement

Just as the control of every manufacturing process within the refinery assures a uniform excellence of petroleum products, so the controlled and specialized manufacture of Pittsburgh Seamless Pipe and Tubing—from the ore to a specified standard—assures a uniform strength and resistance in every pipe and tube.

Pierced from billets of finest open hearth steel, Pittsburgh Seamless Pipe and Cracking Still Tubes are inherently free from weakness of any nature. Their tough grain structure enables them to withstand the most severe stresses of heat and pressure. Their smooth, pitless walls are remarkably resistant to corrosion. The cost of pipe can be measured only by its length of service and judged by this standard Pittsburgh Seamless *is* the most economical of all piping for refinery purposes.



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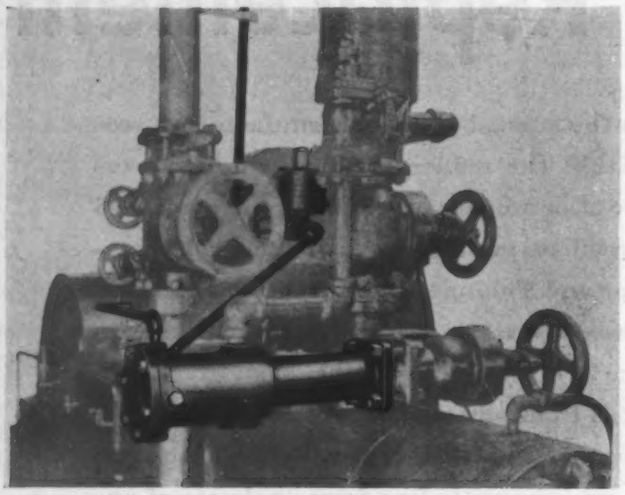
unload the synchronous motor before it can be resynchronized. Applications of this nature include fans, pumps, and motor generator sets. Whenever a voltage dip occurs which will permit the a.c. contractors, relays, and latching magnets on the control to open, the delayed under voltage release push-button seals the push-button contacts closed for a short period. If the voltage returns to normal during this period the control functions as during the initial starting of the motor. If the voltage does not return to normal during this period the push-button drops out and it is necessary to restart the motor after the voltage has returned to normal.

The direct current latching method of obtaining



One of the two E-M automatic ammonia compressor unloaders in service on an Arctic 12x18 DDA ammonia compressor.

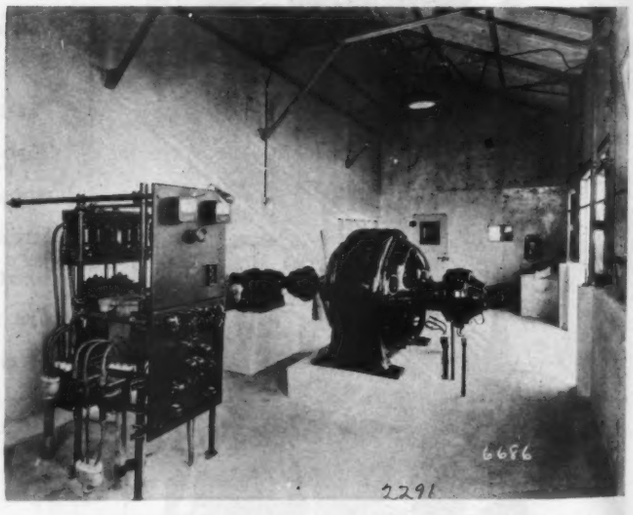
delayed low voltage release is for applications requiring unloading to resynchronize, and includes air and gas compressor and reciprocating pump applications. Direct current latching provides for latching of the line switch and field contractors by means of direct current. This holds the control in the run position for a short period pending restoration of normal voltage. The d.c. operated field contractor helps to keep the motor in step by keeping the field excitation on until the motor is pulled out of step. This prevents interruption in service due to voltage dips of a momentary nature.

The oil immersed vapor-proof starters eliminate the danger caused by arcing of the contractors during their operation in starting and stopping. These are used to an advantage in oil refineries where explosive gases are in the atmosphere. The enclosed starters minimize the possibilities of explosion in some cases eliminate the necessity of building a fire wall between the control and process rooms. This means a very material saving in installation cost.

The unloader is a development for use with frequency responsive control to eliminate operating interruptions to ammonia compressors due to momentary power disturbances. The unloader also makes possible, when used with the proper apparatus, automatic starting and stopping of the motor by means of temperature control.

Unloaders for air compressors are well known and universally used, while the unloader for ammonia compressors is a recent development. An ammonia compressor unloading equipment consists of the following: automatic synchronous motor starters with frequency responsive synchronizing relay, direct current latching of line switch and field contractors, and the E-M Ammonia Compressor Unloader. The unloading equipment includes the following essential parts: unloader valve, pilot valve actuated by field discharge current, check valve in the discharge line, and a small pipe connection, containing regulating valve, from discharge line on compressor side of check valve to the unloader. Figure 4 shows photo of an unloader for ammonia compressors.

As the motor drops out of step, the pilot valve actuates the unloader which operates by a pressure

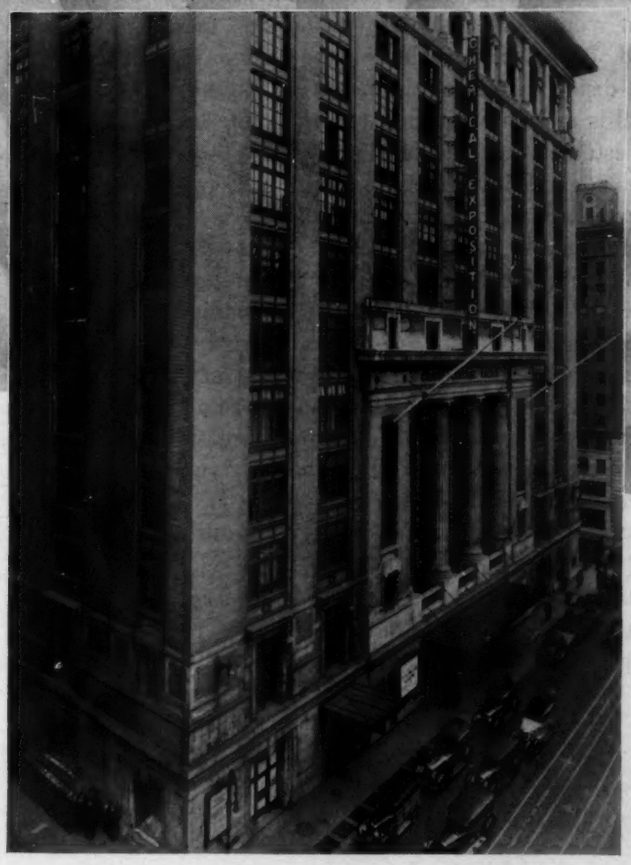


A reciprocating oil pump being driven by a 300 HP, 514 RPM, 2200 volt E-M synchronous motor. The control is of the full voltage type.

differential. The small amount of high pressure gas that is used to actuate the valve is discharged to the low pressure side of the system so that there is no leakage or waste of ammonia gas. The unloader valve of simple mechanical construction operates instantaneously providing dependable operating through momentary voltage dips. Ammonia compressors in oil refineries require uninterrupted service, and the unloader assists greatly in meeting this requirement.

At the Chemical Show: TURBO-EQUIPMENT

BOOTHS 326, 327, 330, 331



Wide range of applications

Turbo-Equipment is in many cases making minutes do the work of hours in mixing liquids with other liquids, solids and gases. There are many applications throughout industry. Some of them may help you if you require compounders, continuous treaters, agitators, scrubbers, mixers, precipitators, acidifiers, causticizers, emulsifiers, saponifiers, hydrators, dissolvers, contacters, blenders, treaters, heat exchangers, gas inductors, washers and allied equipment.

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5479

Selection, Installation and Care of Natural Gasoline Equipment

(*Continued from page* 86)

matic governors on the steam line which allow the pressure to remain constant.

According to the number of steam cylinders the types are simple, compound, triple expansion and quadruple expansion, and according to position either horizontal or vertical. Single direct acting pumps have the advantage in simplicity of working parts and slightly higher operating economy as compared with duplex pumps. Objectionable features are intermittent plunger action resulting in severe pipe shocks at higher speeds which must be taken up by large air chambers.

Duplex pumps give a more uniform flow of liquid. Their operating efficiency is low and the speed is limited. Compound duplex pumps get away from most of the disadvantages of simple direct action pumps. Where fuel is expensive enough to justify the increased initial investment, triple expansion direct acting steam pumps are a good investment. High duty triple expansion pumps are used where flexibility, easy speed adjustment, simple valve motion, and light foundations are desired. Mechanically driven piston pumps are operated by use of rotating drive mechanism. They are either gear or belt driven and may be run at high speeds. The triplex (three plunger) single or double acting types find extended use where a large volume of water of uniform flow is required. Motive power may be delivered through shaft drive from gas or steam engines or electric motors. The main disadvantages are lack of flexibility and indirect drive.

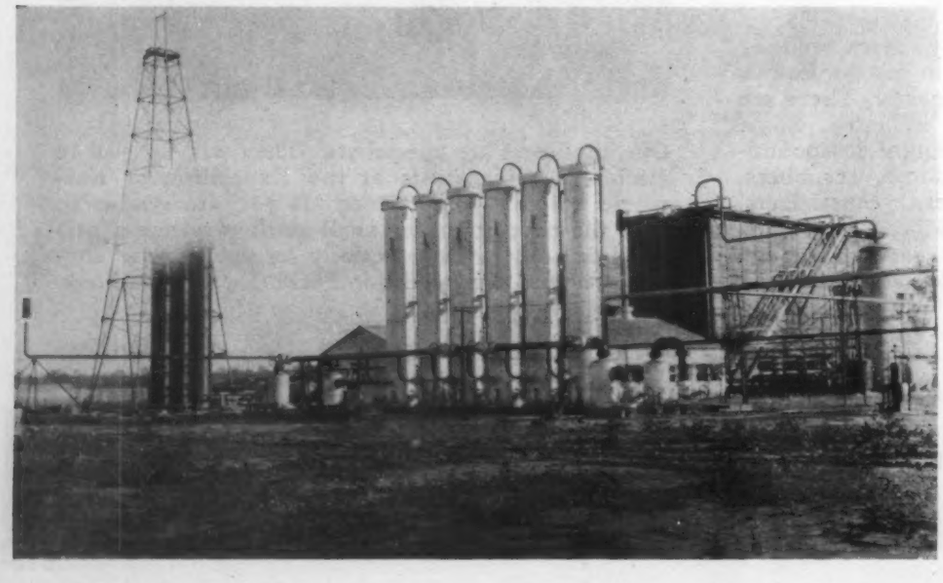
Centrifugal pumps are finding increased popularity among natural gasoline plant engineers for handling both oil and water. This is due to the fact that great improvements have been made by the manufacturers of this type pump insofar as adaptability and dependability are concerned. The fundamental equation for all centrifugal pumps is:

$U_a = V_r \div 2 \tan \alpha + \sqrt{gH \div E_h + (V_r \div 2 \tan \alpha_a)^2}$ where Ua equals peripheral velocity in ft. per sec. V_r equals radial component of absolute velocity W_a; α_a equals vane angle in degrees, g=32.2, H=actual head pumped against in feet; E_h = manometric efficiency. In testing, four readings are taken, viz; Q = capacity, H = Head, M = speed and P = power.

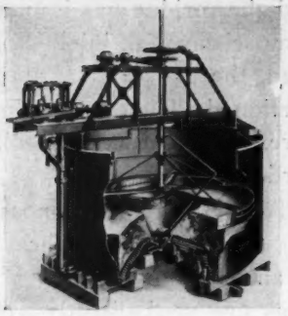
CENTRIFUGAL PUMPS

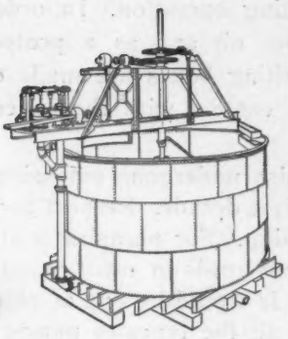
Originally the centrifugal pumps were thought suitable only for the delivery of large volumes of liquid at low head, but due to extensive demand for pumps of this type capable of operating at higher discharge pressures, multistage centrifugals are now available for ranges up to 1000 pounds. Centrifugal pumps are admirably adapted for direct drive by steam turbine as both are high speed low starting load machines. Such arrangements give installation of considerable flexibility. Turbo-generators are suitable for all purposes of light and power, and combinations can be made whereby both motor drive and direct connected centrifugal and rotary pumps furnish all the pumping requirements. Economically it is cheaper to transport power than materials, and turbo-generators offer a means whereby motor driven pumps may be located to greater advantage.

There is much to commend in the use of turbines, centrifugals and turbo-generators for natural gasoline plants. However it should not be forgotten that the positive displacement steam pump offers dependable and flexible means for liquid transfer under all conditions where simplicity and low initial cost are factors. Developments in steam pumping have always



High pressure absorption equipment operating at about 550 pounds in North Louisiana. Louisiana Gas & Fuel Company, Alto, Louisiana.





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kept abreast of the needs of the petroleum and natural gasoline industries. Triple steam expansion drive with oversize liquid end stuffing boxes and spring seating valves are satisfactory pumps for absorption oil circulation. Metal and metal-asbestos packing are used with hot oil pumps. End packed plunger pumps permit tightening of the packing gland without interrupting operation. In order to prevent oxidation of hot oil and as a protection against fire hazard, stuffing boxes are made extra deep so that no part in contact with the oil comes in contact with the air.

Rotary pumps have also undergone extensive improvements within the last decade. Respect for this type of pump is increasing. For pumping a steady flow of liquid against low heads in small quantities, the rotary is excellent. It would be out of place to enumerate and describe all the types of pumps that belong in this category. For ordinary plant purposes where there is need for low cost liquid circulation, one would do well to consider what is at present available in this line. Pumps combining the rotary and centrifugal principles are now used for the transfer of light hydrocarbon mixtures.

CONTROL

Practically every type of measuring recording and control device finds some application to the natural gasoline plant. Instrument manufacturers find a lucrative outlet for their diversified products throughout this industry. The present high state of development in the art of absorption and fractionation is in a large measure due to the perfection of control instruments upon which their efficiency of operation depends. Uniform controls of temperatures, pressures and flows are essential to accurate fractionating and absorption procedure. The extraction plant must be regarded as a unit, lack of control at vital points is evidenced throughout the cycle. Other things being equal, the ideal plant is one of perfectly coordinated equipment operating under exact control. The oil absorption plant uses the greatest amount of control. Therefore statements relative to absorption plants embrace the other less complicated types of extraction plants.

Regulating equipment finds its first application at the source of supply for purposes of controlling vacuum and back pressure on wells. Recording orifice meters or positive displacement meters measure the gas flow. Bleeds are provided for taking temperature, gravity, and gas samples for analyses, as required. Gas traps control the amount of liquid deposited in the lines. Next comes the control and regulation for the booster plants, after which the gas passes through drips and gas coolers to the master meter. At this point gravity and oxygen content may be checked and recorded by continuous methods, samples are taken for laboratory analysis as to gasoline content. The gas passes through the absorber and the residue gas is metered and tested again for comparison with inlet. If more than one absorber is used, the gas to each absorber is metered and proportioned. The correctly operated absorber has pressure, temperature and oil flow regulated and recorded.

Temperature differences between inlet and outlet oil, due to the latent heat of absorption, are needed as an index to absorber efficiency. Liquid level controls are used directly attached to the absorber or to vent tank, insuring steady flow. Manometers record the pressure drop through the column due to frictional resistance. Occasional inspection of the manometer reading is advisable as the tendency to "puke" is evidenced by a rising differential pressure. Where the residue gas goes direct to the suction of booster compressors, a safety tank equipped with liquid level control valve in the sump line should be provided. Such precaution may avoid disastrous results to the compressors in case a shell full of oil goes over the top. The saturated oil from the absorbers may or may not have sufficient pressure to force it through the cycle. In order to reduce the volume of lighter absorbed constituents, this oil may either be vented or pass direct to a fat oil fractionator before pumping.

For purposes of control records should be kept of the vent vapors and frequent analysis made. The oil is picked up by the pump and passed through the heat exchangers to the heater which may be either of the direct fired type or heated by high pressure steam. The outlet temperature of the oil is controlled by an automatic valve in the gas supply line to the burners if direct heated. The best practice here is to get the regulation as close as possible by hand and let the automatic device take up the lag. Double header manifold arrangements with hand valves in the larger connecting lines and the automatic valve in the small line (½" to ¾") are satisfactory. Low pressure regulation is required in the fuel line to steady the gas flow and give even combustion. Where high pressure steam is used for the final oil heating temperature regulators are not necessary if the oil flow is uniform, the heater well insulated and the steam pressure constant. As a matter of precaution, however, it is better to provide mechanical means for controlling the outlet oil temperature by control of steam pressure. Changing the pressure of saturated steam 5 lbs. at 400° F., changes the temperature only 0.8° F. therefore high pressure steam makes a good thermostat.

The fractionating column is the most sensitive to control. A difference of 10 degrees or a change of a few pounds pressure may throw the column off stripping. Fractionator pressures are controlled by sensitive back pressure valves on the outlet of the primary accumulation system. Smooth fractionator operation

Vacuum-producing and condensing equipment . . . designed and built for your requirements by engineers whose experience fits them to understand your problems

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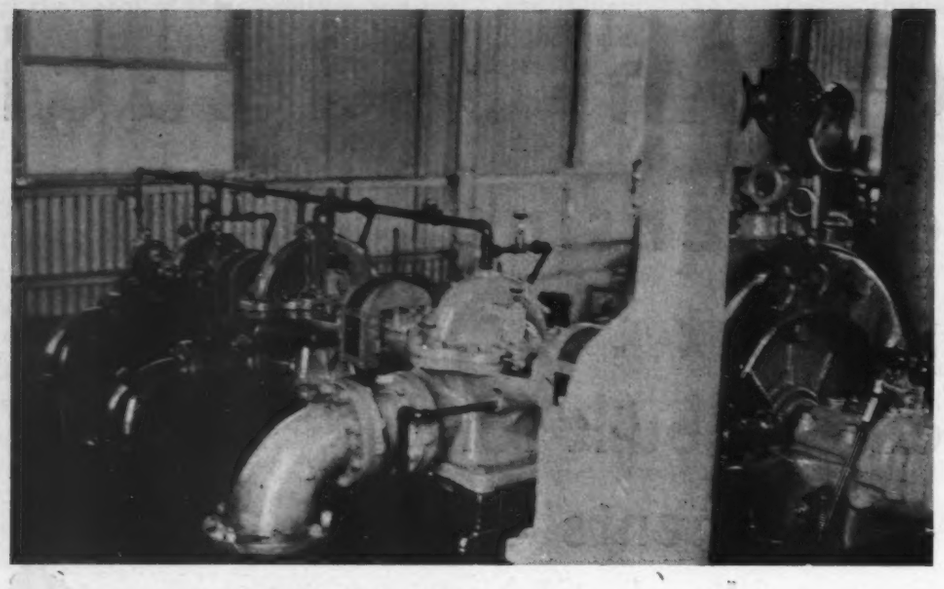


Steam turbine driving pumps in series on single shaft.

depends largely upon the maximum and minimum range held by the regulator. This applies also to temperature regulation for forced or partial condenser reflux, where a smooth line on the temperature chart means steady column conditions and correct end point of product.

However, the bulk of the B. T. U.s are in the inlet mixture to the column. Steady flow, uniform quality and unvarying temperature of feed make the work for the other controls easy. The reboiler temperature should be regulated by the pressure held on the steam condensate reservoir. Stripping steam or gas should be superheated and both temperature and volume automatically controlled. When hot oil pumps are necessary for boosting the oil from the fractionators back through heat exchange and cooling coils to the absorber, close liquid level control provides steady suction. In order to provide uniform composition and volume of condensate the temperatures as well as the pressures of the condensing and accumulator systems following oil fractionation should be constant.

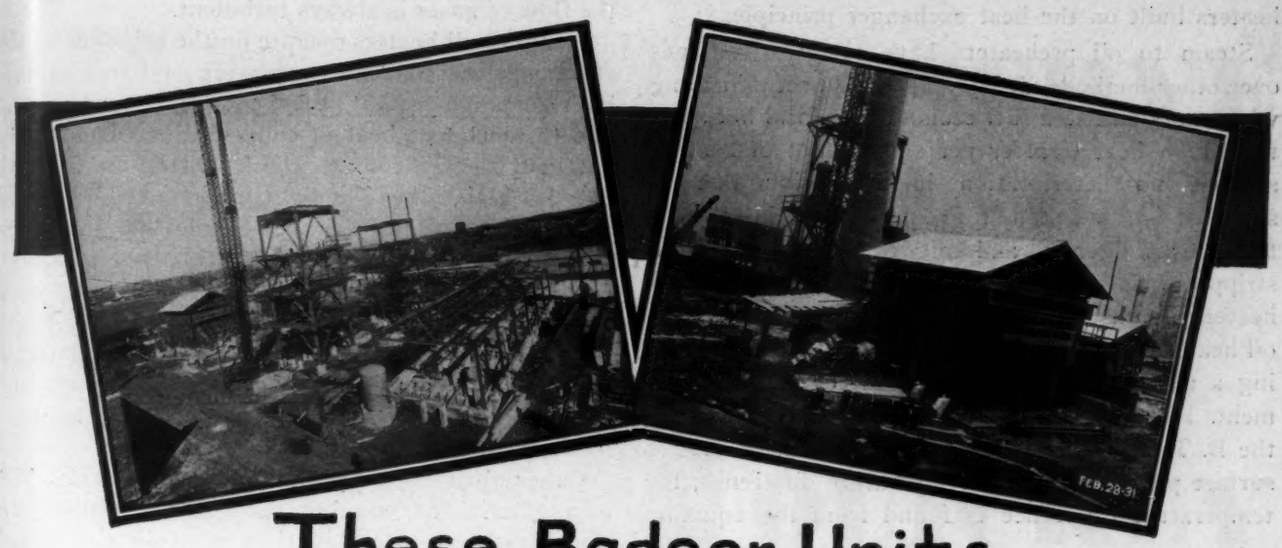
For purpose of accurate record and plant control, pop-off vapors from the accumulators should be metered and periodically examined. The liquid flow from the accumulators is to be kept steady by use of differentially regulated flow meters rather than by liquid level of the tanks. The raw gasoline passes on to the final fractionating system where it is split up into products dependent upon sales outlet and sales specifications. Needless to say accurate temperature, pressure and flow control at all stages of final rectification are essential to efficient separation.

Other uses for measuring and control instruments are pyrometers for fire-box and furnace heaters, meters for measuring the flow of water to the various apparatus, meters and flow controllers for steam. For miscellaneous use, and checking of temperature, indicating and recording instruments are used. Relative humidity of the atmosphere is determined by wet and dry bulb thermometers which may be either simple direct reading or continuous recording. The wet and dry bulb principle may possibly find use as method for testing moisture in gas.

It is felt that no description is necessary of present available instruments as such are adequately described in sales catalogues together with simple instructions for their application, installation and care. In general temperature is measured by liquid expansion, vapor tension, gas expansion and thermocouples. Control valves are operated on the diaphragm principle, or by electric motors or magnets through actuating needle valves or through electric relays. Helical springs, Bourdoni springs and various diaphragm devices are uses for recording pressure. Gas and liquid controlling flow meters operate on the differential pressure drop across an orifice, the variation in differential actuating a needle valve which supplies gas from a suitable source to diaphragm operated valve in the flow line. Electrically operated valves either motor driven or solenoid, are also used. Provision should be made for testing all metering and control equipment before installation. Gas for automatic valve control should be tapped from a source of steady pressure. The condensate and dirt that invariably collect in such lines should be blown out from time to time.

OIL HEATERS AND HEAT EXCHANGERS

Heaters and heat exchange form an important part of the equipment for absorption plants. Heating is chiefly for purposes of oil stripping. This stripping may be accomplished by fire and steam distillation in shell stills, by direct fired heaters of the continuous



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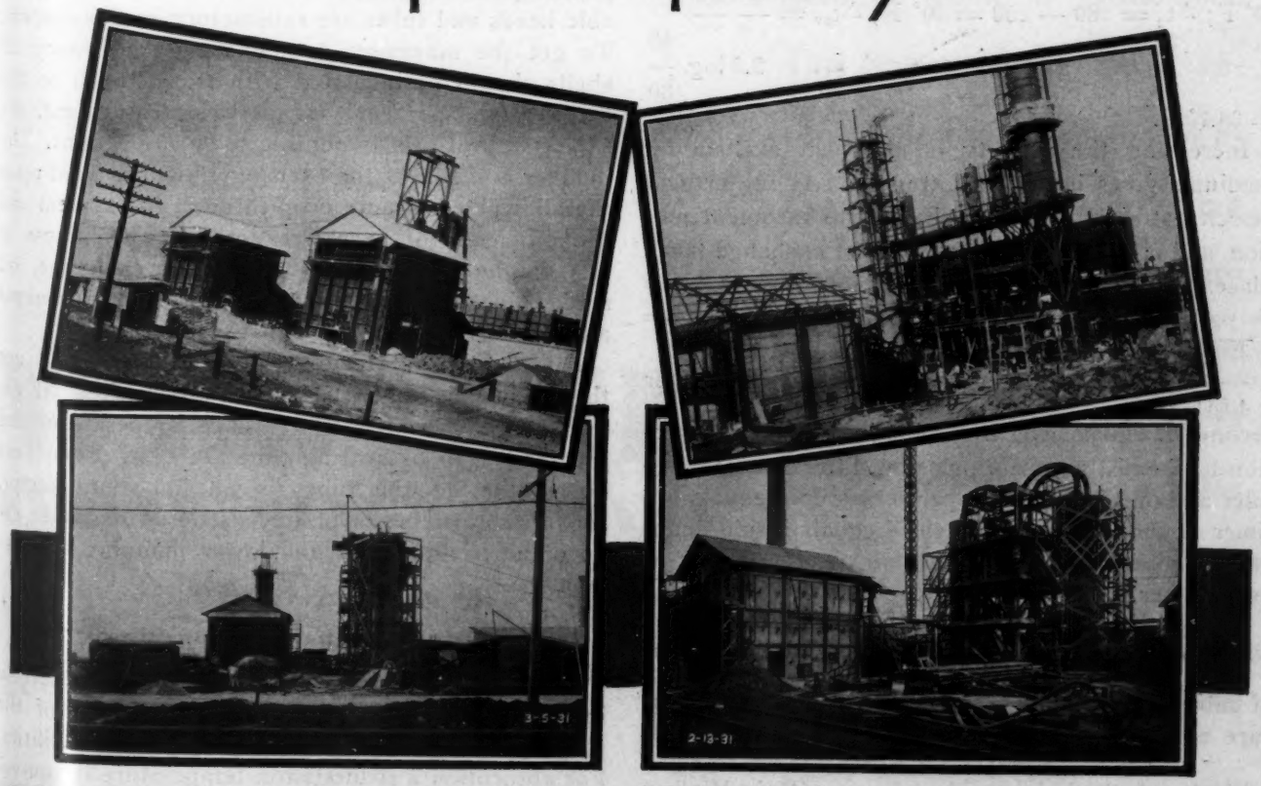

E.B.BADGER&SONS COMPANY

type with fractionator columns or by steam-oil preheaters built on the heat exchanger principle.

Steam to oil preheaters have many advantages over other methods for absorption oil heating among which may be listed fuel economy, no local hot spotting, high heat transfer per square foot of heating surface, no deterioration in absorption due to scorched oil, less pumping requirements due to better tube arrangement and unity of power heating and stripping gas systems. Heat exchangers and steam heaters are usually banked together, the steam to oil heater above the final heat exchangers thus making a neat, compact and easily accessible arrangement. Heat exchanger calculations are based upon the B. T. U. transferred per hour per square foot of surface per mean degree temperature difference, the temperature difference is found from the equation

$$(\Delta t)_{av} = \frac{\Delta t_1 - \Delta t_2}{2.3 \log_{10} \frac{\Delta t_1}{\Delta t_2}}$$

where Δt_1 equals the temperature difference between heating liquid entering and the heated liquid leaving and Δt_2 equals the temperature difference between the cooling liquid entering and the cooled liquid leaving, for example, hot oil enters a heat exchange at 320° F, oil to be heated enters it at 250° F, the 320° F oil drops to say 290° F and the 250° F rises to 280° F during the passage: $\Delta t_1 = 320 - 280 = 40°$ F; $\Delta t_2 = 280 - 250 = 30°$ F; $\Delta t_{av} = \frac{10}{2.3 \log. \frac{40}{30}} = 34.7°$ F.

Increasing the velocity of the heat exchanging mediums gives better heat transfer. At the critical velocity straight line flow changes to turbulent motion, and it is in this region that best exchange takes place. The equation for straight line flow is $U = \frac{\Delta \text{ pgd}}{32} \frac{^2}{G L}$ and that of turbulent flow $U_c = \frac{\sqrt{\Delta \text{ pgd}}}{4 \text{ fp} L}$ where u equals average velocity in feet per second, L equals length of pipe in feet plus correction for bends, p equals pressure difference between inlet and outlet in pounds per square foot equals 144 times pounds per square inch, d equals inside diameter of pipe in feet, V equals absolute viscosity in pounds per second per foot, f equals friction factor which varies with $\frac{\text{dup}}{M}$ a modulus, p equals weight of cubic foot of liquid in pounds at average temperature equals 62.3 X sp. gr. and g equals 32.3 The critical velocity U_c equals $\frac{16 M}{\text{fcpd}}$. (Ref. Walker Lewis & McAdams, Principles of Chemical Engineering.) The above equations apply only to liquids, the flow of gases is always turbulent.

Steam to oil heaters operate on the principle of the steam surface condenser, pressure and temperature both remain constant, the heat transferred is that due to the latent heat of condensation. Due to the excellent surface contact, the heat transfer co-efficient is high, the Orrok equation is U equals $(KCp^2MV^{0.6})/\Theta^{0.125}$ where U equals the co-efficient of heat transfer K equals 630, C equals a cleanliness factor varying from 1.00 to 0.17, P equals steam co-efficient, M equals material co-efficient, V equals liquid velocity in tubes in feet per second and Θ means temperature difference. The equation was determined from heat transfer from condensing steam to water flowing through tubes of various metals.

Other than copper, Admiralty metal ranks high as a material for the tubes. Steel seamless tubes gave a factor of 0.67, much less than when dirty or rusted.

Various expedients are used to obtain increased velocities and simulation of turbulent flow, multipass exchanges is one development. Other devices aim to give spiral or tortuous flow to induce better exchange effects.

The best arrangement for heat exchangers and steam-oil heaters is to bank in tiers, with the ends and connections accessible for cleaning or repair. Parallel-series arrangements with by-pass connections to permit cutting out one or several exchangers without interrupting operations are advantageous. Both tubes and shell should be so constructed as to permit periodic examination and cleaning. Removable heads and tubes are satisfactory in this respect. To get the maximum heat exchange efficiency all shells should be insulated with from 1 inch to 2½ inches of 85 per cent magnesia or equivalent, the saving in heat loss amounting to 90-95 per cent. The number and size of the exchangers will depend upon the allowable pressure drop through the system and the efficiency of exchange desired. Cleanliness is one of the essentials to good heat exchange, oil sludge increases pump horse-power requirements and lowers the over all efficiency.

Direct fired oil heaters still find extensive use througout the industry. To avoid scorched oil the overdraft heater with low furnace temperatures and greater length of heating tube are best. Even heat distribution to the tubes is an important factor, smooth return bends of unconstricted diameter reduce the friction drop and lower pumping requirements.

COOLING TOWERS AND SPRAY PONDS

The cooling equipment plays an important role in natural gasoline plant operation. Much of the plant efficiency depends upon the cooling facilities. For absorption a reduction in temperature is equivalent to an increase in pressure of oil circulation. Condensation of vapors can be effected either by pressure

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The accompanying photograph illustrates an installation of Wilgus Regulators on absorber lines . . . for a gasoline plant in Oklahoma. This is one of the many applications for which the Wilgus Regulator has become standard equipment for many of the larger companies. An Engineering department is maintained by Webster at Tulsa to help with your problems, as well as a service department . . . and a complete stock of regulators.

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or cooling—the most economical condensation being that from the cooling towers. Better cylinder cooling gives higher compression efficiency, suction gas cooling and interstage cooling increase capacity.

Of the two types of towers, atmospheric and forced draft, the forced draft is more positive in action and less dependent upon weather conditions although more expensive to construct and operate. In sections where the prevailing winds are in one direction, atmospheric towers should be so placed as to get the maximum wind effect.

Approximately 85 per cent of the cooling is affected by water vaporization. This vaporization is dependent upon the humidity of the atmosphere, its temperature and volume and the amount of water surface with which it contacts. The finest water spray possible with the maximum exposure give the best cooling effect. Better cooling can frequently be obtained by increasing the water pressure and reducing the size of jet. A certain cooling effect is also obtained by water flow over inclined wooden or other non-conducting surfaces.

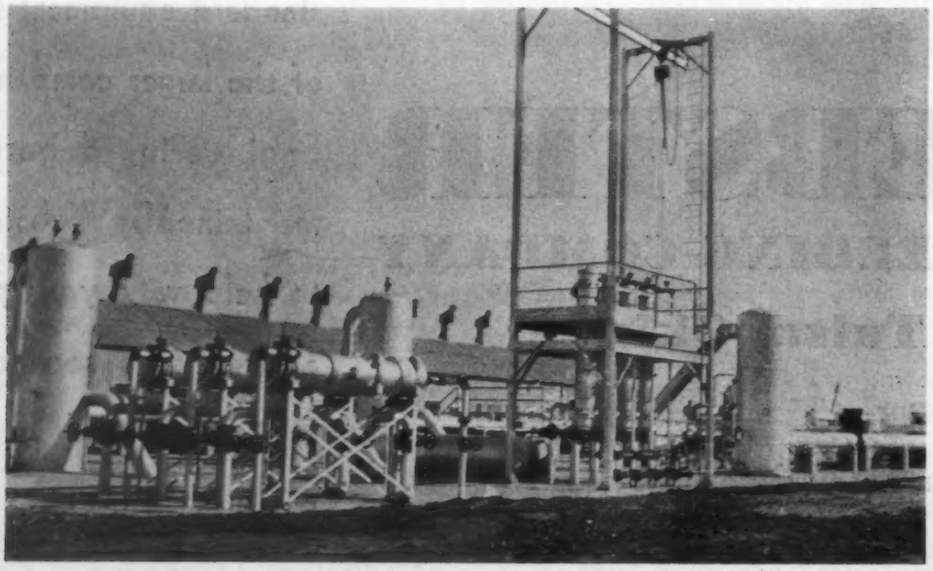
The placing of the various sets of coils influences the efficiency of the cooling tower. In general the inlet sections should be toward the top, as the air above hot coils is both heated and saturated. The hotter sections should be, if possible, somewhat isolated from the cooler sections. Hot water from compressor, cooling reflux, etc., about the plant lowers the cooling capacity if dumped directly into the main pond so separate coolers are advisable for this purpose. Louvres are either horizontal or vertically slatted, the newer installations seem to be mostly of the vertical type. Apparently the vertical slot permits better air circulation. Forced draft towers may find increasing favor, as fans are relatively inexpensive and the power requirements are not large, and can easily be supplied from the excess from turbo-generators. Clean piping, both as regards inner and outer surfaces, is essential to good cooling. The cooling coils are of equal importance with those used for heating, corrosion resisting alloys are worthy of consideration for this purpose.

COMPRESSORS

The relative merits of two-cycle versus four-cycle compression has always been a subject for lively discussion. Choice between the two types is largely a matter of personal preference, both types give satisfactory service, each with its advantages. Ports get away from valve troubles, from cycle gives better purging of exhaust gases without use of pre-compressed air. The use of superchargers is evident from the Otto cycle, $E = 1 - \frac{P_b}{P_c}^{\frac{Y-1}{Y}}$ in which E equals efficiency, P_b equals exhaust pressure, P_c equals compression pressure and y is the specific heat constant usually taken as 1.3. By inspection of the above it is evident that an increase in P_c will result in higher efficiency. Likewise a decrease in P_b gives a higher efficiency showing the importance of unrestricted exhaust. The theoretical horsepower required for adiabatic compression of gas is H. P.

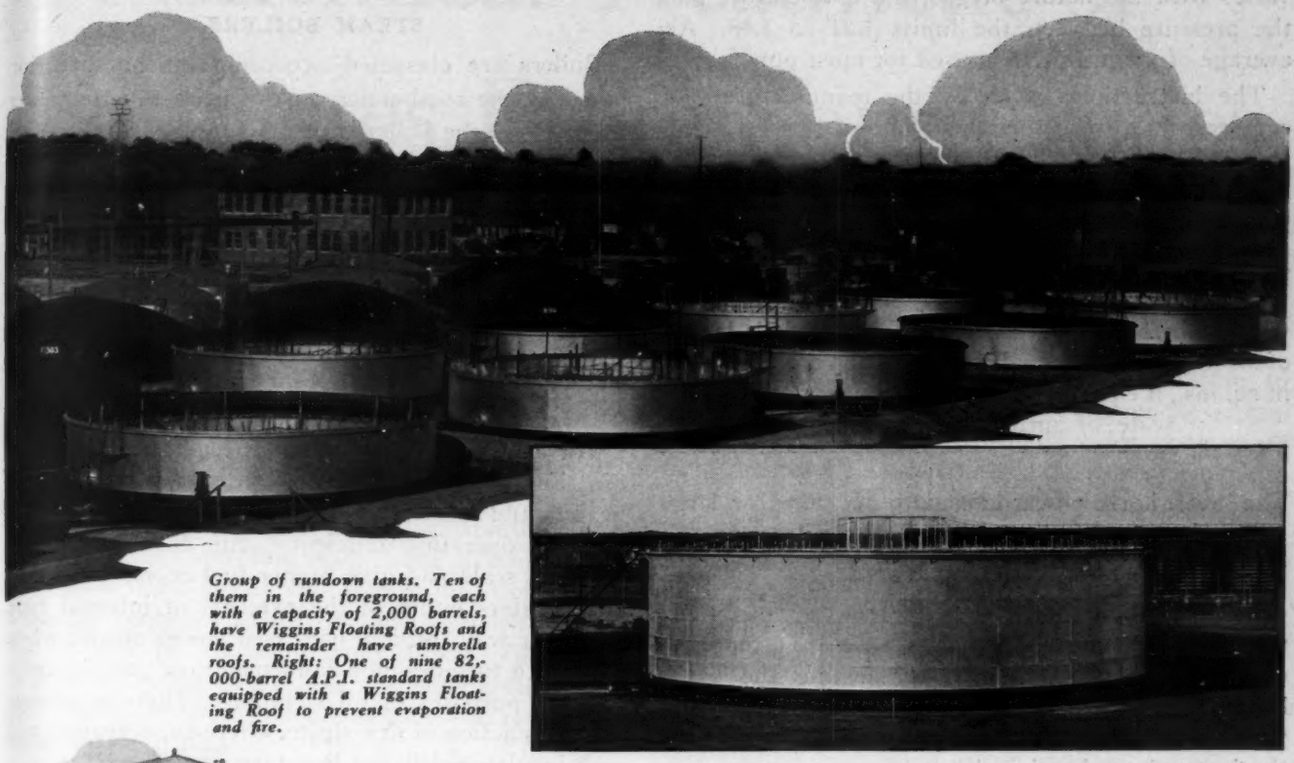
$$= \frac{144\ N\ P_1 V\ Y}{33000\ (Y-1)} \left(\frac{P_2}{P_1}^{\frac{Y-1}{Ny}} - 1\right)$$

where N equals number of stages of compression P_1 and P_2 equal suction and discharge pressures respectively in pounds per square inch ab-



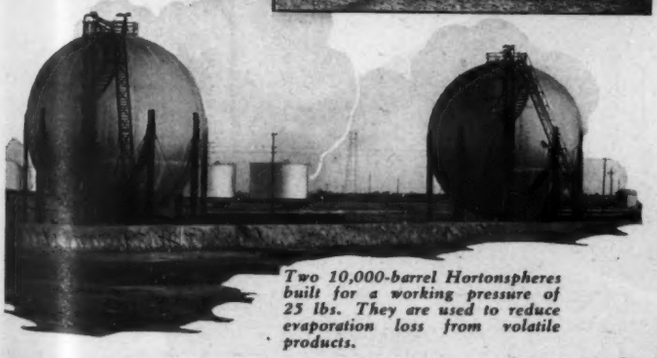
Battery of exchangers operating at low and high pressure in gas cooling work.

For one refinery in Texas » »



Group of rundown tanks. Ten of them in the foreground, each with a capacity of 2,000 barrels, have Wiggins Floating Roofs and the remainder have umbrella roofs. Right: One of nine 82,000-barrel A.P.I. standard tanks equipped with a Wiggins Floating Roof to prevent evaporation and fire.

Left: 100,000-gallon elevated tank installed for general water supply. The tower is equipped with double rods to withstand excessive wind pressure. Below: Two 2,000-barrel agitators.



Two 10,000-barrel Hortonspheres built for a working pressure of 25 lbs. They are used to reduce evaporation loss from volatile products.

THE illustrations on this page represent several types of tanks and special structures which we furnished for one refinery in Texas. They include Horton storage tanks equipped with Wiggins Roofs, Horton rundown tanks with Wiggins and umbrella roofs, agitators, Hortonspheres for the pressure storage of highly volatile products, and a 100,000-gallon Horton elevated tank for general water supply.

Many other refining, producing, pipe line and marketing organizations have benefitted by purchasing all their tanks and platework requirements on one order . . . with consequent saving in time and money.

In addition to the refinery equipment illustrated, we build condenser boxes, stills, absorbers, towers, smoke stacks, tank cars—in fact, any kind of refinery platework.

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Birmingham	1548 Fiftieth St., N.
Chicago	2463 Old Colony Bldg.
Detroit	1520 Lafayette Bldg.
Cleveland	2234 Midland Bank Bldg.
New York	3102 Hudson Terminal Bldg.
Philadelphia	2608 "1616" Walnut St. Bldg.
Boston	1529 Consolidated Gas Bldg.
San Francisco	1051 Rialto Bldg.
Seattle	4312 Smith Tower
Havana, Cuba	Apartado 2507

HORTON TANKS *and* WIGGINS ROOFS

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solute, and y is the ratio of specific heat at constant pressure to specific heat at constant volume which varies with the nature of gas, the temperature and the pressure between the limits 1.31 to 1.08. An average of y equals 1.18 is used for most purposes.

The instructions given by the manufacturers of compressors govern their installation. Properly constructed and installed compressors are practically free from vibration, a favorite test being to stand a coin on edge on top of the gas cylinder. The indicated horse power for gas engines is I. H. P. $= \frac{plgn}{33000}$ where p is found from indicator card, l equals length of stroke in feet, a equals cross section area of piston in sq. ins., n equals number of explosions per minute, p equals $\frac{\text{scale of spring X area covered on card.}}{\text{length}}$ The brake horse power is usually not taken on large compressors directly, b.h.p. $= \frac{2\pi l n w}{33000}$ where L equals length of brake area in feet, w equals net weight on brake and n equals r.p.m. Tested generators are sometimes used for testing the brake horsepower developed. Steam and power driven compressors are at present almost entirely replaced by the internal combustion drive.

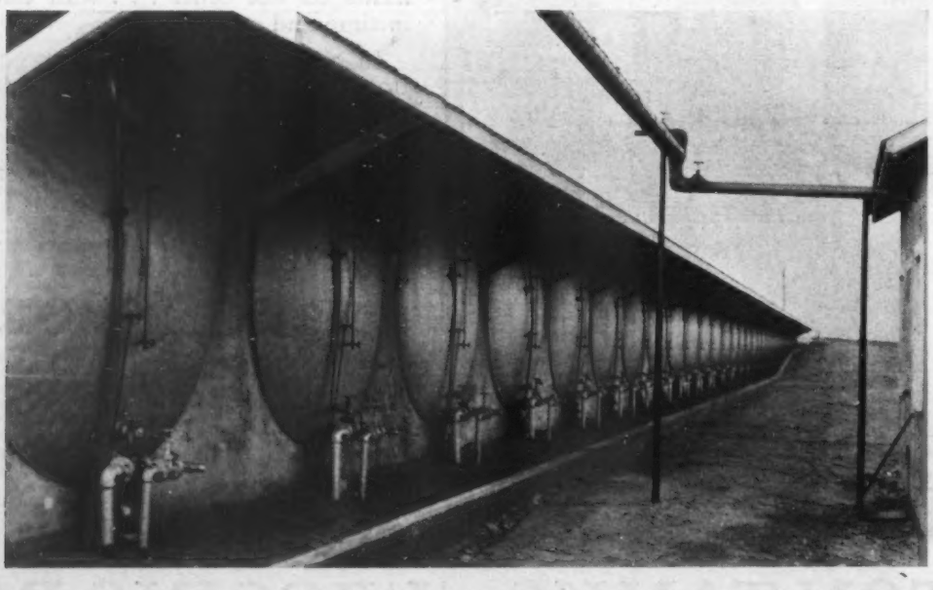
It is worthy of note that centrifugal compressors are now available for discharge pressures up to 100 pounds per square inch with indications of still further developments. Capacities range up to 50,000,000 cubic feet per day, the efficiency increasing with the capacity. Such compressors deliver at uniform discharge pressure regardless of the volume, the pressure being governed by the speed. The future probabilities are that centrifugals will find a place in main compression and absorption plants.

STEAM BOILERS

Boilers are classified according to the direction taken by the combustion gases as fire tube or water tube. Fire-tube boilers are the simplest of all prime power generators, and together with positive displacement pumps, give installations for rugged adaptability and service. The water tube boiler is a much higher mechanical development requiring greater installation and operation attention. Water-tube boilers are especially suitable for the generation of high pressure steam. Better quality feed water is as a rule required for water tubes, fire tube boilers are easier to clean of scale.

For all types of boilers boiler feed pumps, rotary, centrifugal, or piston type, together with boiler feed heaters and facilities for return of steam condensate, increase operating efficiency, cut down corrosion, decrease scale and give higher fuel economy. Steam superheaters either of the external or internal type pay their way through increased power output when used with turbines, non-condensing reciprocal pumps and for purposes of oil stripping. There is always the satisfaction of dry steam where superheaters and well insulated delivery lines are used.

Fractionating and absorption equipment have been discussed in previous articles. The subject of natural gasoline plant equipment is such a broad one that it is difficult to dwell at length on any part in one article. The writer realizes that there are many omissions in this discussion, some of the subject matter under the various sub-heads will be covered more fully at some later date.



Battery of 30 storage tanks, earth covered, by excavating the side of a hill at Skelly Oil Company's Skellyville gasoline plant, Texas Panhandle area.

Chemical Treatment of Distillates From Sour Crudes

By C. B. FAUGHT
Refinery Engineer

ALL sour crudes do not respond to the same general refining procedure. Gasolines from crudes from different West Texas fields require different treating methods. Time is an important factor in making color in certain of these gasolines, while in others it does not apparently affect the final color. Gasoline made from Ector County crude goes off color rapidly during the doctor treat if kept in contact with the treating solution for more than 30 minutes. Gasoline from Howard Glasscock fields is not effected by long contact during treating. These and other problems face the refiner of straight sour crudes.

The marketing outlets determine the procedure of treatment for these gasolines. As practically all of the gasoline made from sour crude contains more than 10 per cent sulfur before sweetening, those refiners who meet the U. S. motor specification on sulfur find acid treating and rerunning necessary. A product of 400 end point or above falls outside of the permissible limit. Several patented processes now under development remove this excess sulfur; but they are not generally used, so will not be discussed in this paper.

Up to the point where acid would be applied, the treatment is identical, regardless of the sulfur requirement. Therefore a discussion of the method of handling the distillate up to this point will be applicable regardless of the subsequent treatment.

REMOVAL OF H_2S

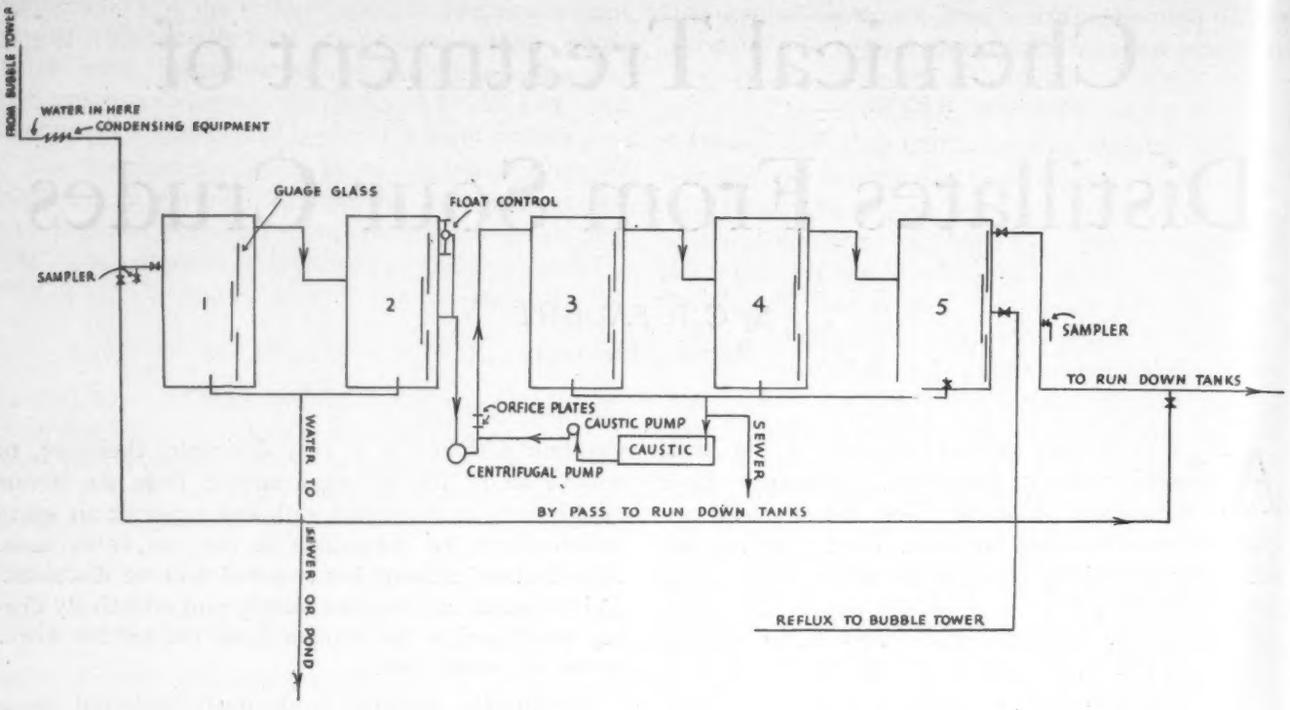
Crudes which contain sulfur in appreciable quantities give off hydrogen sulfide during the primary distillation. This is a foul smelling gas, very poisonous, colorless and is soluble in both gasoline and water. Practically all of this gas which is dissolved in the crude is given off during the pipe still distillation and is carried out of the bubble tower with the gasoline distillate. Some of this sulfide gas will not condense with the stream, or in other words will not be re-absorbed by the stream of gasoline distillate, and will form a volatile gas which if allowed to remain in the distillate until it reaches the run down tank, will leave the tank as a gas, carrying much gasoline with it. It is very desirable, therefore, to remove all of the hydrogen sulfide from the stream before coming in contact with any vapor or air space which might be obtainable in the run down tank. Also further reasons for removal will be discussed. This removal can be done simply and effectively during the travel of the stream from the bubble tower to the run down tank.

Fortunately gasoline lends itself to liquid treatment readily, and with few exceptions, does not emulsify. This makes possible the use of neutralizing agents with very little added equipment. Three chemicals may be used—lime water, soda ash solution, or caustic solution. Ammonia is used but is difficult to handle and if used in excess is corrosive to equipment.

Of the three named chemicals, caustic is the most efficient and most easily handled. Lime water solution will emulsify, leaving a slurry which hangs up in the gasoline, and settles out in tanks. It does not settle clean, leaving a high content of gasoline in the sludge formed, which is difficult to recover. Soda ash works too slowly and requires more chemical than when caustic solution is used.

Since cold water absorbs large quantities of hydrogen sulfide gas, and will do this in the presence of gasoline, the use of water in the condensing equipment is advantageous. Besides absorbing the sulfide gas, it keeps the coils clean and lessens corrosion.

In the lay-out shown in Figure 1, cold water is pumped into the vapor line below the vapor heat exchangers. Since no look boxes are used in this system, the mixture of water and gasoline distillate flows continuously into the first of the two small vertical tanks, and from this tank practically all of the water is drawn off through a water draw off line. Where water is plentiful, this water which contains dissolved hydrogen sulfide, can be discarded into the sewer system. Where water is scarce, it can be admitted into the plant cooling system. However, only fresh water with low content of solids should be used in the washing. If the water is hard, some of its alkalinity will react with the hydrogen sulfide and will deposit in the system. The second



small tank catches any water which is carried over from the first tank mechanically. It is also equipped to draw off this water as it collects. Gauge glasses on these tanks facilitate carrying enough level in the tanks to prevent syphoning out of the gasoline during the drawing off.

From the second tank, a centrifugal pump picks up the raw gasoline and discharges it into a mixing device made of two or more orifice plates. A small stream of 18 Be. caustic solution is fed into the line ahead of the first orifice plate, and the mix is maintained so that all of the hydrogen sulfide remaining after the water wash is neutralized. The suction of the circulating pump can be pinched to maintain a constant level, in number 2 tank or a float valve can be put in the line, adjusted so that a fairly constant supply is fed into the mixer. An excess of caustic solution is maintained as there is no waste. When the reaction is completed no more caustic is used.

Three small tanks are used in this second step. The first tank catches the body of the caustic solution, as the break when using caustic to neutralize is very rapid and the settling is done in very small space and is also very rapid. There is no emulsion. As in the water wash, some entrained solution is carried over, naturally, and this is removed in tank number 4. The sweet stream, free of hydrogen sulfide, flows into tank Number 5, and is used as reflux over the bubble tower, the excess going to run down tanks.

Using average figures for several crudes, the costs and results of this method of sweetening show that from a crude containing 2.5 per cent sulfur, a gasoline distillate containing .5 to .75 per cent sulfur will be produced. The water washing will reduce this sulfur content to 35 to 45 per cent. The final caustic wash will further reduce the sulfur content to 19 to 25 per cent. The cost will average from one to two cents per barrel of distillate.

LESSEN HAZARDS

The advantages of sweetening in this manner are apparent. All danger to workmen is removed. If allowed to remain in the distillate, the hydrogen sulfide will corrode all equipment with which it comes in contact. Tank valves are corroded away rapidly. Iron sulfide is formed in the tanks and free sulfur is deposited on the under side of the roof, on the roof trusses and on the tank walls. When air is drawn into the tanks during the pumping out, and if allowed to come in contact with the iron sulfide, the sulfide oxidizes rapidly, generating sufficient heat to ignite and burn. Many tanks have been destroyed by the ignition of the gasoline vapors in tanks where this sulfide of iron is allowed to accumulate. The explosion is violent and is followed invariably by fire.

Aside from the fire hazard, if allowed to remain in the gasoline distillate, the hydrogen sulfide is reabsorbed, and some free sulfur is dissolved in the distillate. This will give a higher sulfur content to the finished gasoline. A difference of as much as four per cent sulfur has been noted when the distillate has been allowed to stand as much as 24 hours in contact with the sulfide. More free sulfur must be used in the doctor break, where acid treating is not practiced, and less treating plant equipment is required if the gasoline is delivered hydrogen sulfide free.

The caustic used in this neutralizing system can be used repeatedly until spent, but it is best to withdraw it after the gravity is about 11 Be. and rebuild

with stronger caustic. It will be necessary at times to take some of this caustic out of the system, in which case it can be used until its effectiveness is spent, or until the stream shows just sweet when tested with lead acetate.

The size of the openings in the orifice plates can be determined by experiment, by taking the difference of the average pressures on the up and down stream sides of the plates and allowing for a pressure drop sufficiently large to permit an excess capacity of the distillate circulating pump of about 50 per cent. Varying amounts of reflux will be used in the bubble tower from time to time and since this procedure can be carried on with an excess of caustic solution present, considerable leeway may be had. Contact between the caustic solution and the distillate is the only factor involved, as the reaction is rapid.

Gasoline distillates neutralized in this manner are ready for either acid treatment or doctor sweetening. A discussion of doctor sweetening, without acid treating and rerunning will be made since considerable gasoline is being finished without regard to the sulfur content.

DOCTOR TREATMENT

The only difficulty encountered in the mechanical operation of a treating system, whether continuous, semi-continuous or batch, lies in the sulfur break. Large amounts of sulfur, ranging from 50 to 200 pounds per 1000 barrels of distillate treated, present a perplexing problem. Adding sufficient sulfur to continuously break the stream makes continuous treating extremely complicated. A pound or two of sulfur in excess of that needed will show slight corrosion and ten pounds will give a very bad copper strip. Once a batch is positive to the corrosion test it is difficult to blend off as seemingly small portions contaminate a large quantity of negative corrosion gasoline. It is not often that two tanks of distillate will require the same amount of doctor and sulfur. An excess of doctor is not harmful, but is not necessary. Usually the treater shakes up a bottle of the distillate to be treated with a measured amount of doctor solution and gauges the amount of chemicals necessary on the batch. This changing nature of the distillate would require considerable skill and manipulation on the part of the operator, and since air is a help in sweetening, batch operation is more fitted to this peculiar kind of distillate.

The conventional batch treater is the cone bottom agitator, of sufficient capacity to handle the plant requirements. It is fitted with a spray header two or three feet below the roof, and with an air entry in the bottom of the cone. Since from 75 to 300 barrels of doctor per batch is used, a six-inch doctor draw-off line speeds up treating. Doctor recovery is imperative, and an effective method is an open top pan of 300-barrel capacity, equipped with open air sprays and closed steam coils. Four of these will handle a plant treating 4000 barrels of distillate per day.

Some distillates from sour crudes will lose color if kept in contact with doctor for more than 30 minutes, including the time necessary to put the doctor on and break it out. A 2000 G.P.M. centrifugal pump will get the doctor on in from three to five minutes. Air is admitted when the doctor pump is started and when all of the doctor is on, the batch is sweet, and ready for the sulfur. At this point, the air is cut out and the sludge is drawn off. The sulfur is then added. About 75 per cent of the estimated amount is put on first, slowly, and then in small portions until the complete break is made. The use of the lead sulfide which is formed when the sulfur is added, is effective if added to partially recovered doctor. The presence of lead sulfide in the reclaimed doctor speeds up treating and reduces the amount of free sulfur required to break out a batch. It will also speed up the settling and give a cleaner break. Since all of the free sulfur added to the batch does not dissolve in the gasoline immediately, the use of lead sulfide in treating gives a slightly lower final sulfur and lower gum test.

The break does not completely precipitate all of the chemicals, but leaves a haze in the gasoline which settles only after standing. This haze is not apparent to the eye but shows up in the color machine, and makes the gasoline appear much darker than it really is. This colloidal suspension, if allowed to settle in storage, results in tank cleaning, and renders the tank unfit for loading for a period of 24 to 48 hours. In plants where tankage is limited this is a serious inconvenience.

Water washing does not remove this suspended lead sulfide. In fact, it seems that the less water used in the treating plant handling these distillates, the better results are obtained. If a bottle of freshly sweetened gasoline is shaken up with water, and allowed to settle it will be observed that as the water and gasoline separate, the fine black precipitate crawls back up into the gasoline and does not settle again for some time. This same action can be observed in the agitator.

FILTERING

If allowed to stand over the lead sulfide which settles out in the storage tanks, this gasoline will lose color and after a period or four months or so, the anti-knock value is reduced considerably and a motor using this gasoline will knock badly on a pull or at high speed. This darkening has not been observed in clean tanks.

An effective method for removal of the suspension is by the use of small filters or filter presses previously charged with clay. Meshes ranging from 16-30 to 60-90 have been used with the same results. While

some clays polymerize the gasoline under these conditions, certain Illinois clays have no tendency to polymerize or cause the gasoline to go sour. A pressure filter four feet in diameter by six feet in height, with a bottom opening of 16 inches, bushed to six inches, charging one ton of clay will handle 25,000 barrels of gasoline, taking out all the suspended matter, ready to ship, and of better stability and gum test.

Other methods of applying the doctor are in use. In batch operation, the agitator is charged, the amount of doctor required to sweeten is calculated by the method previously described. Approximately 75 per cent of this amount is charged into the agitator and agitated and then enough sulfur is added to break this doctor out. The resultant lead sulfide is then agitated further until the batch is sweet. Usually a very small amount of sulfur must be added to break the batch clean. This method involves more time than the one described, resulting in greater treating losses and is not applicable to those distillates which darken on prolonged contact with doctor solution.

An average cost for doctor sweetening of sour gasoline distillate which has previously been washed free of hydrogen sulfide is $.0175 per barrel of material treated. This cost is based on the recovery of all of the used doctor. This recovery can be repeated indefinitely, as the reclaimed solution containing some lead sulfide treats better than new doctor solution. The loss on treating, where no water washing is done, should not exceed two per cent of material treated, provided large doctor pumps are used and due care is exercised throughout.

A.P.I. Refining Division Renews Co-operative Study

COOPERATIVE work in the study of refining problems and the improvement of refining methods is carried on in the refining branch of the petroleum industry through the Division of Refining of the American Petroleum Institute, and the technical and economic phases of the work will be reviewed at the division's first mid-year meeting to be held in the Statler Hotel at St. Louis, Mo., April 15 and 16.

The division, one of three which comprise the Institute, chiefly will consider at the meeting motor fuel and refinery engineering, but will also hear reports from committees representing the Federal Oil Conservation Board and the Institute of estimates of production and consumption of crude and refined petroleum products, notably gasoline, for the period April 1 to September 30. R. C. Holmes, president, The Texas Company, is chairman of the Division of Refining.

The session of Wednesday afternoon, April 15, will be given over largely to study of the work on motor fuel research being conducted at the U. S. Bureau of Standards under the auspices of the Cooperative Motor Fuel Research Committee sponsored by the petroleum and motor industries and the United States government. Thursday's sessions will interest the refinery engineer, the program calling for consideration of alloy steels for high temperature service, fire protection and waste disposal.

Meetings of the standing committees of the division will be held April 14, 15 and 16. Among these are: Committee on Accident Prevention in Refineries, Committee on Corrosion of Refinery Equipment, Committee on Disposal of Refinery Wastes, Committee on Fire Prevention in Refineries, Committee on Refinery Technology, Committee on Standardization of Refinery Equipment and Committee on Testing Methods and Specifications.

WEDNESDAY, APRIL 15, 2:00 P. M., MOTOR FUEL
Roof Garden

"Progress Toward a Standard for Determining the Anti-Knock Value of Motor Fuels," H. C. Dickinson, U. S. Bureau of Standards, Washington, D. C.

"Automobile Fuel Line Temperatures and Vapor Lock," Oscar C. Bridgeman, U. S. Bureau of Standards, Washington, D. C.

Report of Committee on Testing Methods and Specifications, K. G. Mackenzie, chairman, The Texas Co., New York, N. Y.

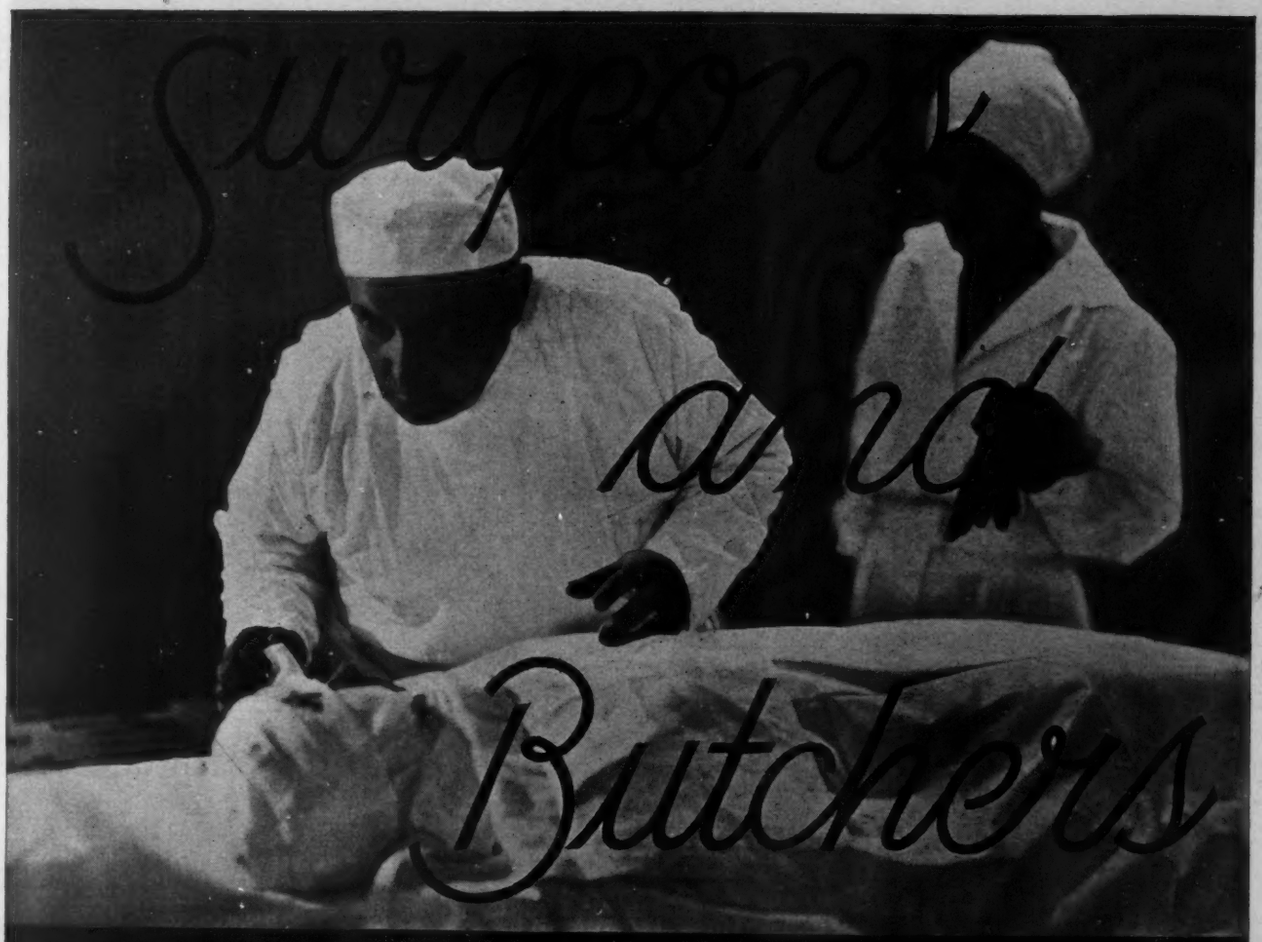
WEDNESDAY, APRIL 15, 8:00 P. M.
Roof Garden

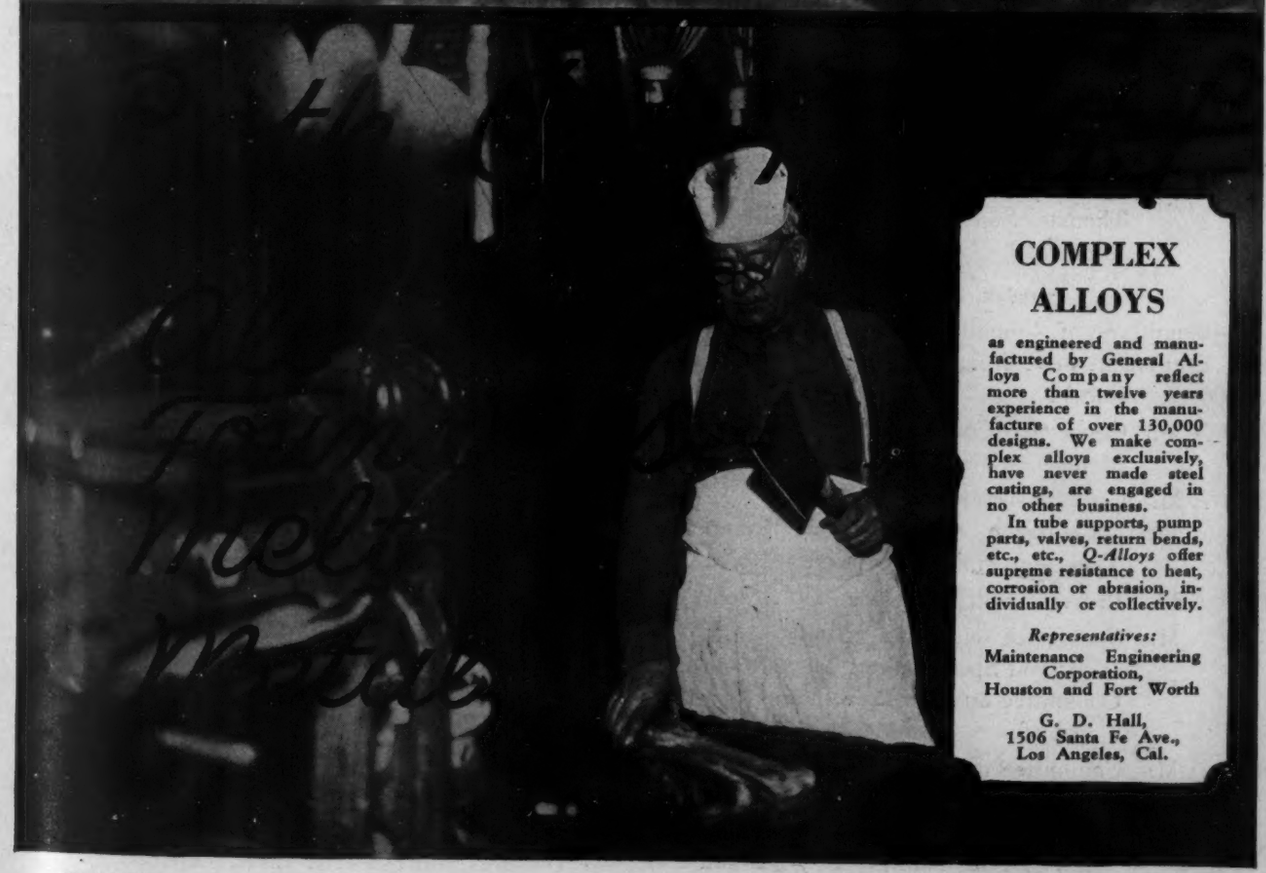
Report of Committee on Refinery Statistics and Economics, chairman, R. C. Holmes, The Texas Co., New York, N. Y.

Report of Federal Oil Conservation Board's Volunteer Committee on Petroleum Economics. (Presentation of reports to be followed by round-table discussion. All refinery executives invited to attend).

THURSDAY, APRIL 16, 10:00 A. M., REFINERY ENGINEERING
Roof Garden

"The 18-8 Iron-Chromium-Nickel Alloy with Particular Reference to Its Characteristics for Cracking Coil





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Service," H. D. Newell, Babcock & Wilcox Tube Co., Beaver Falls, Pa.

"Corrosion Problems Affecting Oil-Vapor Condensers," A. E. Pew, Sun Oil Co., Philadelphia, Pa.

Report of Committee on Corrosion of Refinery Equipment. Chairman, Walter Samans, The Atlantic Refining Co., Philadelphia, Pa.

THURSDAY, APRIL 16, 2:00 P. M.

Roof Garden

Manual on Fire Protection in Refineries, C. H. Haupt, Standard Oil Development Co., Elizabeth, N. J., chairman, Committee on Fire Prevention in Refineries.

A round-table discussion of an outline of the proposed API Manual on Fire Protection in Refineries. Manual on Disposal of Refinery Wastes, J. S. Hess, Sinclair Refining Co., New York, N. Y., chairman, Committee on Disposal of Refinery Wastes. A round-table discussion of waste disposal problems with particular emphasis on a tentative draft of Part II, API Manual, which covers waste gases and vapors. Report of Committee on Accident Prevention in Refineries, chairman, C. W. Smith, Standard Oil Co., (Indiana), Chicago.

COMMITTEE MEETINGS

Monday, April 13

9:00 A.M. Sub-committee of Statisticians of Committee on Refinery Statistics and Economics. Chairman, John D. Gill, The Atlantic Refining Co., Philadelphia, Pa. Room 208.

2:00 P.M. Committee on Standardization of Refinery Equipment. Chairman, Henry Thomas, Sun Oil Co., Philadelphia, Pa. Room 210.

Tuesday, April 14

(Sub-committees of Committee on Corrosion of Refinery Equipment meet from 9 to 11 A. M. in Rooms 204-206 as follows):

9:00 A.M.	Condenser Corrosion	Room 204
	Metal Test Sample Corrosion	Room 206
10:00 A.M.	Crude Fractionating Still Corrosion	Room 204
	Tank and Piping Corrosion	Room 206
11:00 A.M.	Pressure Still Corrosion	Room 204
9:00 A.M.	Committee on Testing Methods and Specifications	Room 202
	Committee on Fire Prevention in Refineries	Room 210
10:00 A.M.	Committee on Disposal of Refinery Wastes	Room 212
	Committee on Refinery Statistics and Economics	Room 208
2:00 P.M.	Committee on Corrosion of Refinery Equipment	Room 204
	Committee on Accident Prevention in Refineries	Room 206
	Committee on Refinery Technology	Room 202

Chairman, E. W. Isom, Sinclair Refining Co., New York, N. Y.

Wednesday, April 15

10:00 A.M. General Committee, Division of Refining — Adam Room

Chairman, R. C. Holmes, The Texas Co., New York, N. Y.

Thursday, April 16

4:00 P.M. Executive Committee, Institute Board of Directors — Room 210

Chairman, E. B. Reeser, Barnsdall Corp., Tulsa, Okla.

7:00 P.M. Institute Board of Directors (Dinner) — Adam Room.

Natural Gasoline Association Program Arranged

The tentative program for the annual meeting of the Natural Gasoline Association of America has been arranged to provide papers and discussion on three major subjects, economic, plant operation and technical. In announcing the program, Ray E. Miller, secretary of the organization, said:

"It is not probable that any changes will be necessary in this program and it is the hope of the program committee that it will be followed verbatim at the convention."

The program of the morning of the first day, May 19, will be devoted to the reports of standing committees and other business activities of the organization. In the afternoon there will be consideration of the economic situation as regards natural gasoline. A full day of subjects of interest to plant operators and managers will be given May 21. Technical considerations will take up the last day of the meeting, May 21.

All meetings will be held in the Mayo hotel, Tulsa. Entertainment will be provided by the Natural Gasoline Manufacturers' Association, whose final program will be announced later.

The annual convention program follows:

TUESDAY, MAY 19, 1931

Morning Session

Opening session—10:30 a.m.

Welcoming address—Frank L. Chase, Lone Star Gasoline Company.

President's address—Dr. E. R. Lederer, Texas Pacific Coal & Oil Company.

(*See page 186*)

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Appointment of nominating committee.

Report of active standing committees.

1. Gas contract committee—chairman, T. R. Goebel.
2. Standardization committee—chairman, George P. Bunn.
3. Technical committee—chairman, R. C. Alden.
4. Specifications committee—chairman, E. W. Zublin.
5. Sales managers committee—chairman, A. T. Scherer.
6. Gas Testing committee—chairman, George P. Bunn.
7. Aviation committee—chairman, R. C. Alden.
8. Standard forms committee—chairman, A. H. Menuet.

Afternoon Session

Prepared economics round table discussion.

Mid-Continent:

1. "Production and Transportation of Natural Gasoline"—F. E. Rice, Phillips Petroleum Company.
2. "The Natural Gasoline Situation from the Standpoint of the Natural Gas Pipe Line and Carbon Black Manufacturer"—W. E. Reardon, Columbian Gasoline Corporation.
3. "The Marketing Outlook for Natural Gasoline"—D. E. Buchanan, Hanlon-Buchanan, Inc.

California:

1. "Production, Transportation and Markets of Natural Gasoline in California"—W. W. Robinson, Jr., The Texas Company.

WEDNESDAY, MAY 20, 1931

Morning Session

1. "New Developments in Plant Processes and Equipment"—G. M. Davidson, Empire Oil & Refining Company.
   Discussion by E. A. Wooden, Sinclair Oil & Gas Company.
2. "Plant Management Kinks"—John Power, Chemical Products Company.
3. "The Disposal of Residue Gas"—D. C. Williams, Continental Oil Company.
   Discussion by D. A. Sillers, Lone Star Gasoline Company.

Afternoon Session

1. "A Resume of the New Specifications for Natural Gasoline"—R. C. Alden, Phillips Petroleum Company.
   Discussion by Dr. George G. Brown, University of Michigan.
2. "Fractionation Control"—S. S. Smith, Shell Petroleum Corporation.
   Discussion by W. G. Hiatt, Phillips Petroleum Company.
3. "The Kettleman Hills of Today"—C. R. Burgess, Standard Gasoline Company.

THURSDAY, MAY 21, 1931

Morning Session

1. "The Status of the Liquefied Petroleum Gas Industry"—G. G. Oberfell, Phillips Petroleum Company.
   Discussion by W. G. Watkins, Skelly Oil Company.
2. "Motor Fuel Developments"—Dr. George G. Brown, University of Michigan.
   Discussion by G. G. Oberfell, Phillips Petroleum Company.

Afternoon Session

1. "The Refinery, from the Natural Gasoline Man's Viewpoint"—Emby Kaye, Skelly Oil Company.
2. "The Determination of the True Vapor Pressure of Liquids and Its Value to the Petroleum Industry"—E. J. Squire, Shell Oil Company.
3. "Vapor Recovery in the Refinery"—Speaker to be selected by the Western Petroleum Refiners Association.

Drake's "First Oil Well" Gets Institute's Protection

Through the co-operation of the American Petroleum Institute a movement has been started for the preservation of the site of the Drake well near Titusville, Pennsylvania. It is planned to protect the "first oil well" from further damage and to give all interested people in this country opportunity to have a part in the enterprise. It is planned to do the required protective work, acquire sufficient land around the well site to form a park and provide for proper maintenance through state appropriations.

Plans for the project are in the hands of a committee appointed by the board of directors of the Institute, consisting of W. R. Boyd, Jr., executive vice president of the institute, chairman; Chas. L. Suhr, president and general manager, The Pennzoil Company; W. M. Irish, president, Atlantic Refining Company; L. M. Young, president, South Penn Oil Company, and Christy Payne, head of the Standard Oil Company of New Jersey natural gasoline interests.

It is estimated that $60,000 is needed to build a retaining wall, clean, excavate and drain, perform landscaping, construct park roadways, and erect a caretaker's cottage with a room set aside for relics and records relating to the Drake well or to other early petroleum history. Subscriptions to this fund should be sent to W.R. Boyd, Jr., chairman, American Petroleum Institute, 250 Park Avenue, New York City.

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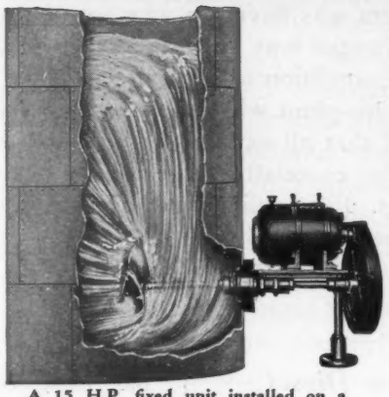

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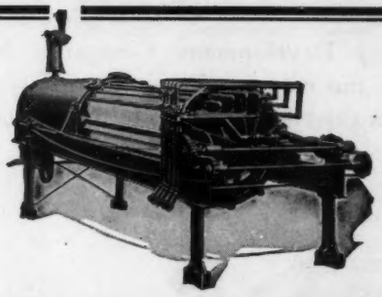

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By GEORGE REID

Reference Fuels Made Available

Two standard reference fuels have been prepared by Standard Oil Development Company for distribution among refiners operating knock rating laboratories. The fuels have been carefully calibrated on a series 30 Ethyl Gasoline Company engine in terms of octane numbers using tetraethyl lead and C. P. Benzol. Fuel comparisons were made using the bouncing pin method and the data were determined for two different temperatures. Delivery will be made in 50-gallon drums or in 10-gallon cases of two compartments, aiding in the shipment of five gallons each of reference fuels A and B. Orders for these fuels should be sent to Standard Oil Development Company, attention Mr. Ross H. Dickson, Room 734, Broadway, New York.

Down in the Bedplate

E. S. Newton, plant superintendent, McPherson Compressor Station, McPherson Oil & Gas Development Company, McPherson, Kansas, is the man in the picture—ready for work rather than the photographer, but good sport enough

E. S. NEWTON
—an engine needed rings.

to be shot "as was." He was caught dressed for engine repairing and in the act. He seemed to like the hour or two vacation that he had while he was talking things over in February with J. C. Albright who has written an article about his plant. One of his twin Millers was having a new set of rings put in, and Mr. Newton was down in the bedplate of it inspecting the condition of the cylinder. The article descriptive of his plant will appear in an early issue. J. C. A. noted that all exposed fittings and controls were housed-in, especially those on the high pressure absorbers. Everything there has been put in a house which is heated with steam, so that a sudden cold snap can not shut the plant down.

Modern Diesel Engine Practice

This book, one of the most complete on the subject yet published, was prepared to combine a text for study and reference and a practical manual on operation and repair in one volume. It includes instructions suitable for the owner, operator, repairman and engine salesman, and is also valuable to all students. Every fact requisite to a complete knowledge of Diesel engine construction, operation and maintenance is included.

The information is presented in non-technical language, and is suitable for classroom use or home study. The presentation indicates a recognition of sound methods of engineering apprentice training. The author has the ability to digest long and painstaking experience and study of the subject, and he has had actual sales and service experience with well known Diesel builders, such as Fairbanks, Morse & Company and the Anderson Engine and Foundry Company.

Twenty-one chapters detail technical data for Diesel applications, and review modern installation practice, including the Standards of the Diesel Engine Manufacturers' Association and the Underwriters Regulations for Standard Installation. Numerous tables, charts and operating data are analyzed.

High speed oil engines of recent design for all mobile applications, such as shovels, dredges, draglines, industrial and railroad locomotives and tractors are shown. Several chapters with layout drawings consider the stationary Diesel engine. All auxiliaries, air filters, pyrometers, exhaust silencers and centrifuges are described and illustrated. The instructions on lubrication, maintenance, operation and repair of engines are unusually complete.

The Packard-Diesel aircraft engine and the Ingersoll-Rand locomotive oil engines are described and illustrated in detail, as well as the Cummins Automotive

Diesel, which has received a certificate of performance because of its use in a racing automobile and for holding economy records in road work.

The book is published by Norman W. Henley Company, 2 West 45 Street, New York City, or copies may be secured through The Gulf Publishing Company, Houston, Texas. Price $6.00.

Committee Will Study Neutralizers

The American Petroleum Institute's Division of Refining has appointed a subcommittee to study neutralizers. This committee is headed by L. G. Metcalt, Union Oil Company of California, chairman. It will study and investigate the use of neutralizers and report. A questionnaire has already been mailed to refining companies. The committee consists of L. W. Parsons, Tidewater Oil Company, Bayonne, New Jersey; S. S. Shaffer, Humble Oil & Refining Company, Baytown, Texas, and W. J. Whiteman, Standard Oil Company (Indiana) Whiting, Indiana.

Lloyd E. Eldridge Dead

Lloyd E. Eldridge, vice president and assistant general manager of Philfuels Company, subsidiary of Phillips Petroleum Company, died Saturday, March 14, in Detroit. Death, at 31, came as the result of streptococcic throat infections followed by other complications. Mr. Eldridge was well known in the natural gasoline industry. In 1922 he was with the Chestnut & Smith Corporation in Texas as a chemist, following which he was assistant superintendent for Baltic Gasoline Company. Later he was with Humble Oil & Refining Company in the refining division. In January, 1928, he was made office manager for Philfuels Company, being later transferred to Detroit when the company headquarters was moved to that city.

Gas Measurement Short Course

The eighth Southwestern Gas Measurement Short Course is to be held in the Engineering building, University of Oklahoma, Norman, Oklahoma, April 21, 22, 23, with Professor W. H. Carson of the College of Engineering, director of the course in charge of the sessions. Dr. W. B. Bizzel, president of the university, will extend his annual address of welcome at the opening session.

The purpose of the course is to provide, through cooperation of the various interests annually represented, an opportunity for men in the natural gas and natural gasoline manufacturing industry to get together and study problems pertaining to the measurement and regulation of dry and casinghead gas.

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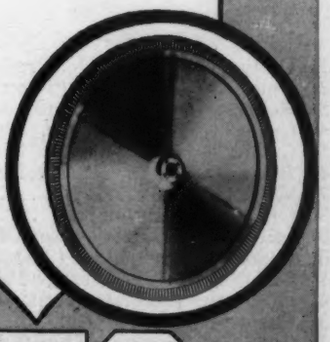

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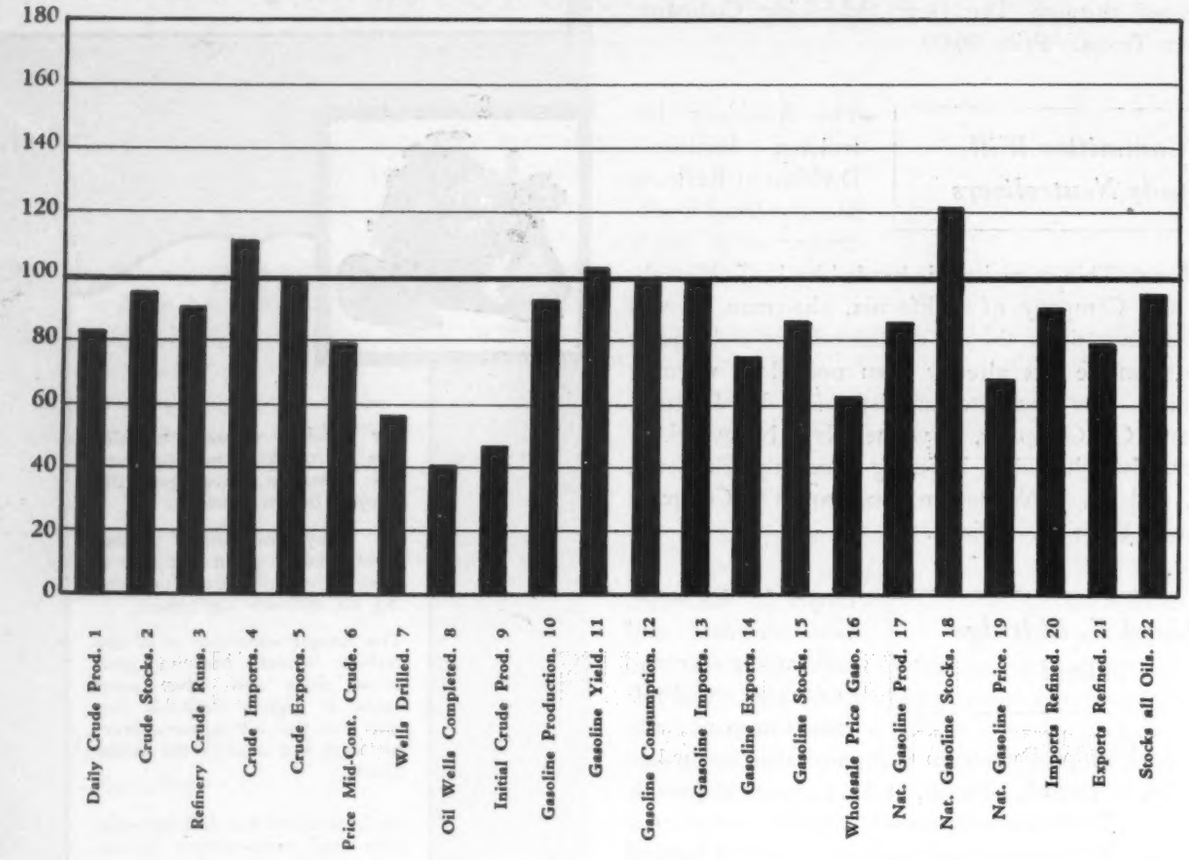
Salient Oil Industry Factors for February, 1931, Expressed in Per Cent of February, 1930. Heavy Line (100) Represents February, 1930



Oil Industry Barometer—February, 1931

Index of Salient Factors—Current and Cumulative

	Factors—	This Month			2 Months Ending Feb. 28		
		Last Year	This Year	Index (a)	Last Year	This Year	Index (a)
1	Daily Average Crude Production (Thous. Bbls.)	2,652	2,166	82	2,610	2,146	82
2	Total Crude Stocks (Thou. Bbls.)	539,336	503,980	93	539,336	503,980	93
3	Refinery Crude Runs (Thous. Bbls.)	72,414	65,249	90	152,577	135,275	89
4	Crude Imports (Thous. Bbls.)	4,321	4,789	111	9,771	9,142	94
5	Crude Exports (Thous. Bbls.)	1,731	1,710	99	3,539	3,629	103
6	Posted Price 36 Gravity Mid-Cont. Crude (Per Bbl.)	$1.20	$.95	79	$1.26(b)	$.95(b)	75
7	Wells Drilled*	1,463	815	56	3,381	1,971	58
8	Oil Wells Completed*	881	348	40	2,023	867	43
9	Initial Crude Production (Thous. Bbls.)*	991	460	46	1,676	1,257	75
10	Gasoline Production (Thous. Bbls.)	33,949	31,328	92	70,603	64,036	91
11	Gasoline Yield—Average Per Cent of Crude (d)	42.02	43.27	103	41.50	42.64	103
12	Domestic Gasoline Consumption (Thous. Bbls.)	26,509	26,133	99	52,252	52,977	101
13	Gasoline Imports (Thous. Bbls.)	953	948	99	2,032	2,064	102
14	Gasoline Exports (Thous. Bbls.)	4,840	3,606	75	10,415	8,509	82
15	Gasoline Stocks at Refineries (Thous. Bbls.)	53,229	45,355	85	53,229	45,355	85
16	Refinery Price U. S. Motor Gaso.—Group 3 (Cents)	6½	4	62	6¾(c)	4⅛(c)	61
17	Natural Gasoline Production (Thous. Bbls.)	4,248	3,631	85	8,658	7,771	90
18	Natural Gasoline Stocks (Thous. Bbls.)	572	692	121	572	692	121
19	Price Grade "A" Natural Gasoline, Group 3 (Cents)	5½	3¾	68	5⅜(c)	3⅝(c)	67
20	Imports of All Refined Oils (Thou. Bbls.)	3,224	2,917	90	7,030	6,518	93
21	Exports of All Refined Oils (Thou. Bbls.)	10,123	7,992	79	22,160	18,083	82
22	Total Stocks of All Oils (Thou. Bbls.)	699,377	658,285	94	699,377	658,285	94
	Weighted Index of Supply	.....	.....	92	.....	.....	94
	Weighted Index of Demand	.....	.....	88	.....	.....	71
	Weighted Index of Prices	.....	.....	70	.....	.....	68

*Exclusive of Rocky Mountains. (a)—Last Year—100.
(b)—Weighted Average. (c)—Monthly Average.
(d)—Straight run and cracked gasoline only.

Opportunity for Expansion Of Fuel Oil Markets

By H. J. STRUTH
Staff Economist

A BULLETIN issued by Standard Statistics Company, New York, setting forth facts concerning the natural gas industry, cites low oil prices as a vigorous competitive factor in retarding the sales of industrial natural gas. It is stated in this bulletin that oil possesses many of the important attributes of gas and is successfully competing on a price basis. Assuming that eight gallons of fuel oil are approximately equivalent to 1000 cubic feet of natural gas on the basis of their respective heat values, 5500 cubic feet of gas will then do about the same work as one barrel of oil. Prices for fuel oil as well as gas vary considerably with the locality and grade, but the following facts give an approximate idea as to the prices at which gas must be sold to compete with fuel oil, on a thermal unit basis:

Fuel oil per barrel	Gas per million cubic feet	Fuel oil per barrel	Gas per million cubic feet
$2.00	$.36	.105	.19
1.75	.32	1.00	.18
1.50	.27	.95	.17
1.40	.255	.90	.165
1.30	.24	.80	.145
1.20	.22	.70	.13
1.10	.20	.60	.11
		.50	.09

Costs of burning which, for oil, are only slightly greater than for gas, have not been taken into consideration above, but it will be seen readily that gas must be sold at a very low figure to compete with fuel oil on a price basis. The following statement is significant of the situation prevailing in the competitive fuel market and offers the oil industry some well-founded food for thought and action in cultivating increased outlets for its surplus fuel oil supply:

"As an indication of the manner in which competition has been developing of late, we have been reliably informed by manufacturers of a number of instances in which they have been able to draw contracts for oil at prices which neither coal nor gas could meet.

"Such circumstances gather additional significance when considered in connection with the fact that such reports come, in some cases, from manufacturers who can use either gas or oil and who are buying for plants in districts thought to be 'sure-fire' outlets for natural gas in large quantities."

The foregoing data and statements call to attention a distinct opportunity for refiners to make an intensive drive for a market for fuel oil that awaits only cultivation by the oil industry. Literally thousands of large manufacturing plants now using natural gas or coal are live prospects for the purchase of industrial fuel oil. During the past few years, vast natural gas pipe line systems have been built, primarily designed to carry natural gas to industrial centers, in competition with coal. Today, with the price of crude at low ebb, with fuel oil selling on the spot market for only slightly more than 50 cents a barrel, refiners are in a position to establish a sizeable market for fuel oil; a market outlet that could quickly correct the condition of over-supply and result in a healthy source of revenue and a back-log for the gasoline market.

With crude oil plentiful, at low prices, the refiner is in a position to make contracts with large industrial fuel consumers that have been gradually embraced by the natural gas industry. On a price basis, many manufacturers now using gas could readily be converted to the use of fuel oil, sacrificing little, if any, advantage and benefitting materially by the difference in cost of fuel used.

Bureau of Mines statistics of the natural gas industry show that the average price of industrial natural gas delivered to consumers in the United States is about 12.2 cents per 1000 cubic feet. In some states the rate is materially higher, particularly in Indiana, New York, Ohio and Pennsylvania. In these states the rate for natural gas averages from 42 to 56 cents per 1000 cubic feet. In a number of states, such as Kentucky, Mississippi, Missouri, Tennessee, West Virginia, Maryland and North Dakota, the rate for industrial gas is 20 cents or more per 1000 cubic feet. It is readily seen, on the basis of the foregoing table, that present market prices for fuel oil, plus delivery costs, offer an opportunity for refiners to launch a vigorous drive for industrial fuel oil outlets. At any rate, the table of equivalent gas rates and fuel oil prices shows that gas can only compete successfully with fuel oil at points adjacent to natural gas production, whereas distant industrial centers must pay substantially higher prices for gas that cannot compete with the delivered cost of fuel oil. The table indicates the extent to which fuel oil can successfully compete with gas; it dictates that refiners should lose no time in cultivating the large market for industrial fuel that must, in these times, consider cost.

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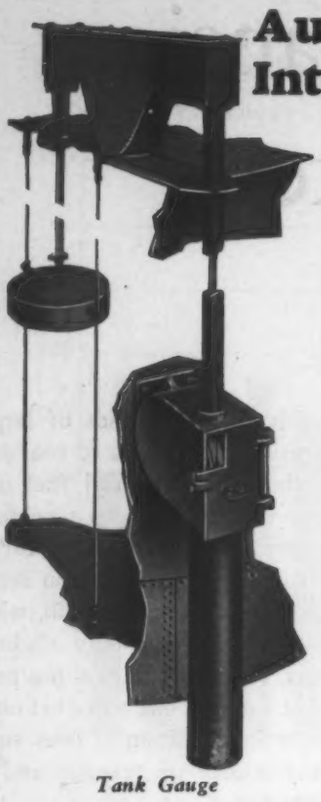

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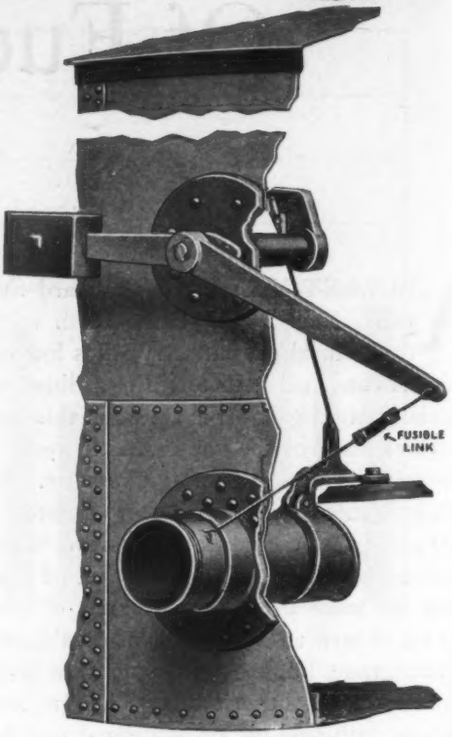

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REFINERY AND GASOLINE PLANT ACTIVITIES

New Plants – Construction Notes – Personnel Changes

THE month's news is indicative of continued activity in enlargement and further construction in the refining and natural gasoline industry. Nine new domestic refineries are proposed or under construction.

The protective tariff on gasoline in Canada continues to encourage construction of new refineries in that country and two more were announced this month. The Spanish monopoly proposes a refinery at Barcelona.

Enlargement and expansion programs continued to be reported, which is in line with past years when construction work speeds up in the spring. The present work, however, is being done not to increase capacity because of economic justification, but is necessary because of technical reasons brought about by the scientific progress within practically all departments of the refining industry. Stabilization units, new improved cracking units, vacuum distillation equipment, and supplemental process equipment necessitated through obsolescence, account for the continued expenditures of the refining and natural gasoline manufacturing industry. Details of activities reported throughout the past month are presented in the following notes.

Altitude Petroleum Buys Peerless Plant at Chanute Altitude Petroleum Corporation has purchased the refinery formerly operated at Chanute, Kansas, by Peerless Oil & Refining Company. The plant has 2500 barrels skimming capacity and is equipped with one Jenkins cracking unit. R. Werlin has been superintendent in charge of operation at this plant, and no change has been announced to date.

Plan Small Refinery for Santa Barbara Mesa Field H. H. Barnes et al are considering the erection of a small refinery near Santa Barbara to handle production from the Santa Barbara Mesa field. Financial headquarters of the new company has been established at Pasadena. The Santa Barbara Mesa field yields a heavy oil.

Black Gold Officials Plan To Double Plant's Capacity Black Gold Oil Company, Oklahoma City, through its president, D. A. Corcoran, has announced that it will double its refining capacity at its plant in the Oklahoma City field. Present rated capacity is 1000 barrels per day.

British-American Plans Refinery for Montreal British-American Oil Company, Toronto, Canada, has announced that it is planning construction of a refinery at Montreal. Capacity is not reported. The plant is to supply the company's trade in Eastern Ontario and Quebec. A site on the St. Lawrence River was acquired several years ago and has been used for a storage and distribution plant.

Skimming Plant Planned By Brady, Texas Resident M. D. Carson, resident of Brady, Texas, has announced that he will start construction of a skimming plant at that point. The first unit is under construction and operations should start within 60 days. Crude will be transported to the plant by tank truck.

Continental Plans to Enlarge Refinery at Florence, Colorado Continental Oil Company will enlarge capacity at its Florence, Colorado, refinery through the addition of a high pressure tube still unit to be erected at once.

Deepwater Starts Building New Type Fractionation Unit Deepwater Oil Refineries, Inc., Houston, has started construction of a new low pressure tube still and bubble type fractionation equipment. The unit was designed by, and is being erected under the supervision of R. Q. Traweek, superintendent of the refinery. The unit is to have a capacity of 3000 barrels per day.

Eason Oil Plans to Build New Type Gasoline Plant Eason Oil Company is reported to be constructing a new absorption type natural gasoline plant at Cresent, in west central Logan County, Oklahoma. Stabilization equipment is included in the construction program. Soars & Lovelace are in charge of construction.

Exeter Oil to Remodel Hynes, California, Plant Exeter Oil Company, which recently purchased the refinery formerly operated by Perfection Refining Company and more recently by Italo Petroleum Company at Hynes, California, is remodeling the plant to handle 5000 barrels of average crude. The remodeled plant will be equipped to make kerosene, distillates and fuel oil, in addition to gasoline. A cracking unit will be added as soon as market requirements warrant the expansion. One of the tallest stabilizers ever built will be erected during the course of overhauling the plant.

REFINERY AND GASOLINE PLANT ACTIVITIES

General Producers Plant At Bowling Green Is Sold

General Producers Company, under which name a refinery at Bowling Green, Kentucky, was operated several years ago, has sold the plant to E. L. Lowther et al of West Virginia. The plant is located at First Street and the Louisville & Nashville Railroad, Bowling Green. Purchasers' plans have not been announced.

Small Plant to Be Built In Terra Bella District

G. H. Gillons, Los Angeles, plans the erection of a small refinery to serve the Terra Bella field. Mr. Gillons has perfected certain improvements in connection with a continuous distillation process. The refinery will be built with a view to handling only lubricants. Capacity is reported at 100 barrels per day. Only a small production has been developed in the Terra Bella district and the field is not considered as a commercial producer so far as clean oil is concerned. It is claimed that the proposed process will handle the present production satisfactorily.

Gulf Refining Company Completing New Plants

Gulf Refining Company has completed and placed in operation its new Pittsburgh refinery with rated capacity of 6000 barrels and one 3000-barrel cracking unit. In addition its Toledo plant (formerly Paragon Refining Company) enlargements are about completed and this plant is being increased to 12,000 barrels daily crude capacity with 6000 barrels cracking capacity. A plant of similar capacity is under construction at Cincinnati which is expected to be in operation by August 1.

Small Refinery Building In Rooks County, Kansas

A. H. Krueger, Natonia, Kansas, is reported building a small refinery in Section 11-19-16w in the Rooks County, Kansas, field. Two producing wells are located near the refinery.

Start Construction of Plant In Fruitvale, California, Area

The L. O. Oil & Refining Company is reported to have begun construction of a refinery on the L. C. Osborn property in the Fruitvale field of Kern County, California. Capacity is reported at 500 to 1000 barrels daily, with first units to be in operation within 90 days.

New Refinery Is Planned At Artesia, New Mexico

R. S. Lord, president, Hope Engineering Company, Mt. Vernon, Ohio, and his son, John Lord, Durango, Colorado, are reported to be planning the erection of a refinery at Artesia, New Mexico, according to newspaper reports. A pipe line system to connect the plant with wells now having no outlet is also proposed.

Skimming Plant Is Planned For Nowata, Oklahoma, Area

J. E. Perkins and Charles Brocker of Kansas City, Missouri, are reported to have purchased equipment for a skimming plant to be erected at Nowata, Oklahoma, to refine stripper well production in that area.

Standard of New Jersey Is Involved in Alcohol Suit

Petroleum Chemical Corporation, a subsidiary of National Distillers Products Corporation, has filed suit against Standard Oil Company of New Jersey for alleged infringements of patents covering production of alcohols from petroleum gases, in the United States District Court, New Jersey district. Standard Oil Company of New Jersey and Empire Oil & Gas Company have been operating alcohol production plants under patent agreement for the past several years.

Petroleum Chemical Corporation has been sponsored by Barnsdall Oil Company, Blair & Company and A. D. Little, Inc., chemical engineers. This company has an alcohol plant at the Barnsdall, Oklahoma, refinery of Barnsdall Refineries, Inc.

Pure Awards Contracts for Gasoline Recovery Plants

Pure Oil Company has awarded contract to Foster-Wheeler Corporation for the fabrication and construction of two complete absorption and stabilizer plants. One of these will be located at Marcus Hook, Pennsylvania, and the other at Smiths Bluff, Nederland, Texas. The Marcus Hook unit will handle 6,000,000 feet of gas per day at 65 pounds pressure, and 5,000,000 feet daily at 35 pounds pressure. The Smiths Bluff unit will handle 8,000,000 feet per day at 65 pounds, plus 5,000,000 at 35 pounds pressure. Gas will be supplied from the skimming and cracking units at the respective refineries.

New Refinery Planned for Houston Refining District

Republic Oil Refining Company is erecting a 5000-barrel plant at Texas City, in the Houston refining district. It is proposed that the plant will operate on light crude delivered by tank car from the Big Lake field deep sand production. D. W. Hovey, formerly with Waverly Oil Works Company, Pittsburgh, is in charge as manager. Further information as to plans and executive personnel appeared in Refiner and Natural Gasoline Manufacturer, issue of March, 1931, page 60.

Plan 2500-Barrel Plant For Longview, Texas Area

Slack Petroleum Company, through its president, E. G. Slack, has announced plans for the construction of a 2500-barrel refinery, skimming type, to be erected at Longview, Texas, immediately. W. A. Geppelt, consulting engineer, is in charge of construction.

Sparton Assumes Control of Newly Purchased Properties

Sparton Refining Company, which recently acquired Shreveport-Eldorado Pipe Line Company's 10,000-barrel refinery at Shreveport, and 125 miles of pipe lines and five pumping stations, has taken charge of the properties. The new company is building, through its holding company, Atlas Pipe Line Company, Inc., a $750,000 pipe line to the East Texas oil fields with terminus at Longview, Texas. E. R. Ratcliff is president of Sparton Refining Company. Sam D. Hunter is chairman of the board and vice presi-

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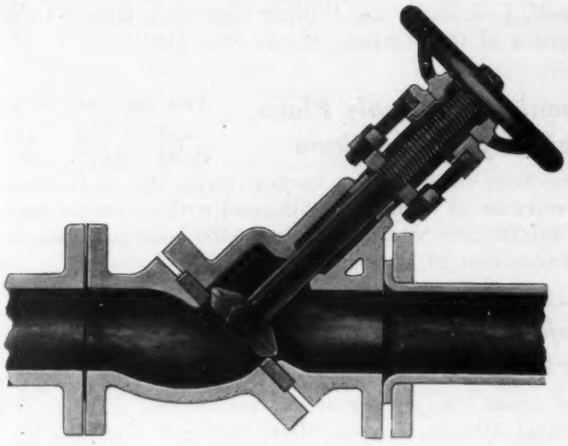

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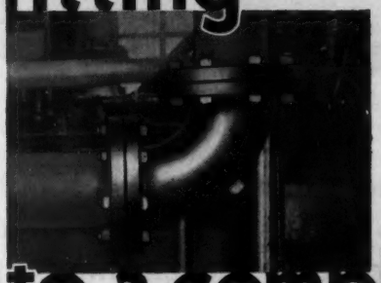

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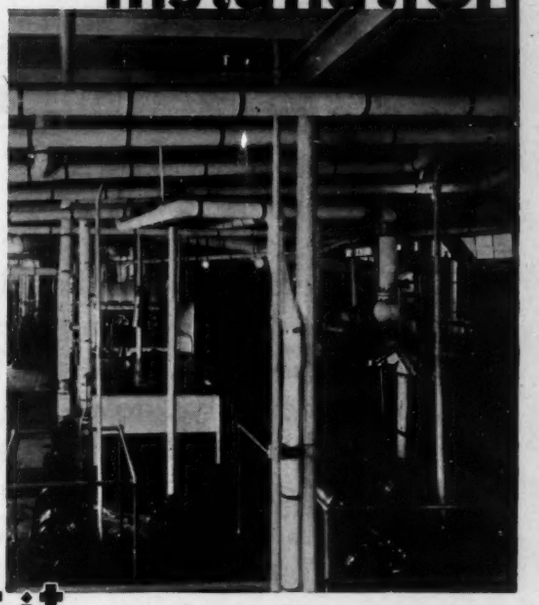

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Refinery and Gasoline Plant Activities

dent. J. F. Atkins, is secretary and member of the board of directors. Other officers and directors are: B. H. Gray, vice president and treasurer; J. K. Wadley, R. T. Moore, J. W. Olvey, J. B. Beaird, C. D. Keen, Guy Oakes, W. C. Woolf, J. S. Reily, and William Chrisman, directors. Headquarters of the company are at Shreveport.

Spanish Monopoly Plans Refinery at Barcelona The Spanish Monopoly, according to the official report of the Free Zone of Barcelona harbor, states that it is proposed to erect an oil refinery at this point with an annual capacity of 400,000 tons at a cost of 50,000,000 pesetas, which figure includes cost of auxiliary equipment.

Refinery to Be Constructed In Wainright District, Canada Stilson Products, Ltd., has been incorporated to construct and operate a refinery in the Wainwright district of East Central Alberta, Canada. The plant will employ a process designed by W. H. Stilson for extracting gasoline, distillate and lubricants from the Wainwright heavy crudes.

Vulcan Building Cracking Unit at Vernon, California Vulcan Refining Company, a recently organized subsidiary of Vernon Oil Refining Company, Vernon, California, is building a 1000-barrel unit on part of the site unused by the parent company on East 26th Street, Los Angeles industrial district. Officers of the new company are J. A. Brower, E. O. Brower and W. N. Brower, who are also president, vice president and treasurer, respectively, of the parent company—operating a 3000-barrel skimming plant at Vernon. A. T. Swearingen of San Bernardino, California, and F. M. Moore, Downy, California, are also reported interested in the new company. Reports state further that the new plant will employ a new process designed by Neil F. Blaine, formerly vice president, Nacogdoches refinery, Nacogdoches, Texas.

Plan Small Capacity Plant For Archer County, Texas Will Young, Archer City, Archer County, Texas, proposes the erection of a 250-barrel capacity skimming plant to operate on crude from wells in the immediate territory which have no pipe line connection. Claude Semm, Wichita Falls, formerly with Gulf Refining Company at its Sweetwater, Texas, plant, is in charge of construction and operation.

Alfred Bishton Botfield, originator of high temperature cement and founder of that industry in the United States, died recently in Miami, Florida, at the age of 83.

Mr. Botfield in 1899 established Botfield Furnace Specialties Company in Philadelphia.

In 1915 he retired from active business, and the conduct of Botfield Furnace Specialties Company was assumed by his son, Leonard Bishton Botfield, who is now president of the succeeding Philadelphia concern, Botfield Refractories Company.

New Equipment for the Modern Plant

Nopak Valves

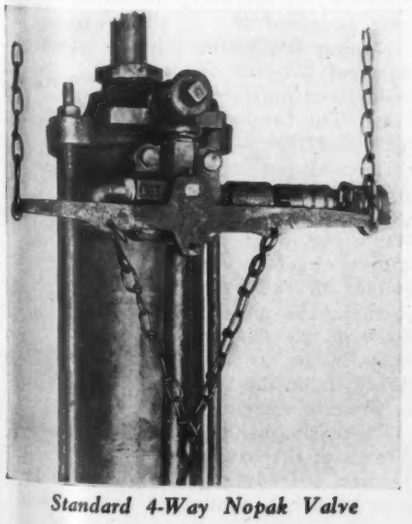
GALLAND-HENNING MANUFACTURING COMPANY

Galland - Henning Manufacturing Company, Milwaukee, Wisconsin, announces a full line of valves designed on the patented NOPAK principle for the handling, control and distribution of compressed air, gas, water, and oil. The valves are produced in three types termed standard valves for relatively low pressure work, heavy duty valves for air, water or gas pressures up to 500 pounds per square inch, and hydraulic valves for oil pressures up to 5000 pounds per square inch.

Heavy Duty Nopak Valve

NOPAK valves are made in standard sizes for one-fourth-inch to two-inch pipe opening, with larger sizes specially designed, and are available in straight-way, three-way and four-way styles.

The primary object of the NOPAK valve is to provide valve equipment which will remain tight and leakless, not only in the closed position, but likewise in the operating position, since the greatest loss is incurred in valves when open. The Nopak principle utilizes the pressure to assure a positive seal of valve parts. The pressure is at all times against the valve disc holding the lapped surfaces of the disc and valve body sealed. This also assures ease of valve operation. The design permits openings practically equal to the area of the pipe lines, giving an unrestricted flow. The company's Bulletin 57 gives many illustrations, engineering data, and blue prints of valve assembly of all types manufactured and will be sent to those interested upon request.



Standard 4-Way Nopak Valve

Saturation Controller

FOXBORO COMPANY

Foxboro Company, Foxboro, Massachusetts, announces an instrument for the control of gas saturation or rehydration. This instrument, known as the Foxboro saturation controller, is designed to aid in the work of correctly saturating natural gas to prevent the drying out and subsequent leakage in any line formerly used for the distribution of manufactured or wet gas.

The operating principle of the saturation controller is unique. Basically it is a wet- and dry-bulb psychrometer. Control of the saturation point is maintained by the wet-bulb thermal system which operates a controlled valve in the steam line leading to the aspirator. A hookup is possible whereby oil fogging can be accomplished through the same steam aspirator. A sample of the saturated gas is drawn from the line by a motor blower which circulates it over the wet bulb thus insuring the correct velocity for evaporation. The dry-bulb thermal system operates a power diaphragm inside the instrument which resets the saturation point to conform with changes in temperature in the line. Changes in the gas line temperature will constantly reset the saturation point so that the gas will always be saturated at the gas line temperature.

The saturation controller is of the air-operated type. On this particular service, however, air is unnecessary since the controller can be operated directly from the gas pressure in the line if that pressure is two pounds or over.

Foxboro Company has prepared a bulletin D.M.F. No. 589 entitled "Gas Saturation Control" which describes this instrument in detail. A copy may be obtained by writing Foxboro Company, Foxboro, Massachusetts.

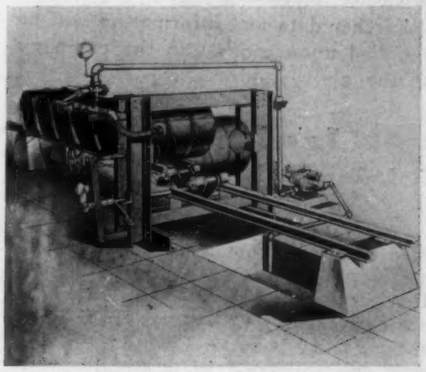
Drum Reconditioner

WATSON-STILLMAN COMPANY

Watson - Stillman Company, Roselle, New Jersey, has added to its line of barrel house equipment a new machine to recondition steel drums.

The machine dedents, cleans and tests in one operation.

The drum to be reconditioned is rolled from the back rack on to the rocker saddle, clamping heads tightened, and a flexible hose is connected to bung hole bushing with quick locking coupling. An alkaline solution from the sump is pumped into the drum. The pump then builds up hydraulic pressure as indicated on the gauge to dedent and at the same time test the drum.



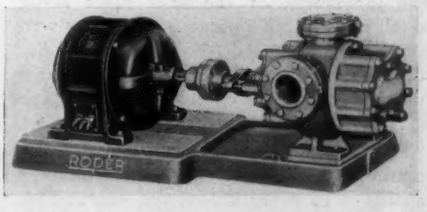
Drum Reconditioner

To complete the operation, the pump is by-passed by the three-way valve, hose is disconnected, clamping heads are released and the rocker heads are released and the rocker saddle is tripped by the foot pedal allowing the drum to roll on to the rack to drain to sump. The solution is used until its strength is spent.

New Transfer Pump

GEORGE D. ROPER CORPORATION

George D. Roper Corporation, Rockford, Illinois, has placed on the market a new transfer pump with a 300-gallon per minute capacity. It is designed particularly for unloading tank cars and transferring liquids from storage to truck tanks rapidly.



Roper Transfer Pump

The manufacturers describe it as a rotary gear pump incorporating the modern developments in design and construction, such as the "always primed" feature, positive bearing lubrication, and operation at motor speeds. The rotating elements are two 30 degree continuous herringbone gears. The stuffing box on the pump is packed

with three waxed packing rings. Extra close bolt spacing on the pump casing for bolting on face plates is made to prevent leakage when it is operated under pressure. It is designed for direct connection to the motor.

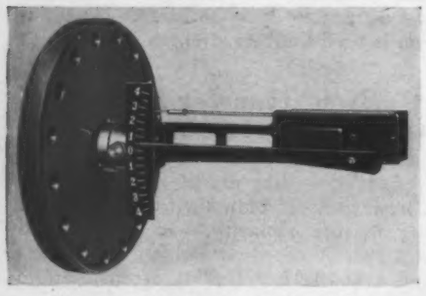
The pump is furnished with either large, hardened and ground journals running in metal bearing bushings, for pumping non-lubricating liquids, or with a double row of ball bearings on ends of both shafts, for pumping lubricating liquids.

Further data and information will be supplied upon request to the company at the above address.

Level Indicator

C. J. TAGLIABUE MANUFACTURING COMPANY

C. J. Tagliabue Manufacturing Company, Park and Nostrand avenues, Brooklyn, New York, is now marketing the new Tagliabue level indicator incorporating electric contacts for operating signal lights in the control house and, since open contacts are prohibited in most oil plants, sealed mercury contacts are used. It is necessary, however, that these contacts be kept at a certain distance from the flange face so as not to be affected or destroyed by high temperature at the flange. The tilt switch holding the mercury bottle is more than a foot away from the flange.



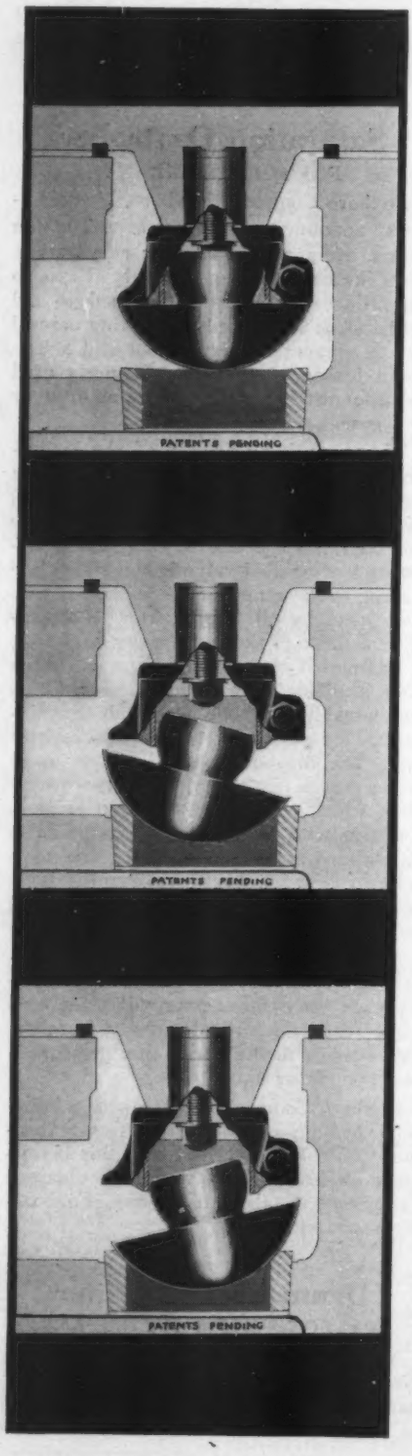
The movement of the float after being suitably reduced operates a rocker-arm on the spindle and the motion of the rocker arm is communicated to the mercury tilt switch by a long connecting link or rod.

This same motion also revolves a spindle which ends in a long red pointer causing it to move across the scale. This scale, which can be read at considerable distance, has white figures and graduations on a black background, is graduated from zero to four inches in each direction.

All electrical connections and wires are protected from accidental damage and from moisture. The stuffing box at the flange end of the device is packed with high temperature resistant material.

An air pilot valve may be incorporated in the construction to make the device a combined indicator and level controller.

Installation is made by means of the extra heavy steel flange furnished with the device which may be attached to a tee, thus forming a float chamber or mellon; or the flange may be directly attached to the wall of the tower, still or other apparatus.



Ball Guiding Valve

CALMEC MANUFACTURING COMPANY

Calmec Manufacturing Company, Ltd., 5817 Riverside Drive, Los Angeles, announces a new pump valve for reciprocating pumps used in oil well drilling, pipe line, refinery and general service. It is of the conventional ball and seat type.

The Calmec ball guided valve is claimed to be the first really new departure along the line of pump-valve construction in a number of years. A clear understanding that the actual piston speed is more than twice as great as piston travel has led the manufacturers of the Calmec valve to make a radical change in valve design.

Calmec ball guided valve is designed to deflect the fluid, causing less friction and has a tendency to prevent the valve lifting higher than necessary to discharge the fluid; also to eliminate part of the pressure, which insures a shock-free operation at the highest speed at which the fluid will flow into the pump without excessive slip. It is designed to decrease the high pressure between suction and discharge valves, to result in less piston and valve slip with a corresponding increase in pump efficiency.

Since to decrease pressures it is necessary to increase areas, and to decrease slip it is essential that valves be guided properly, thereby insuring quick, positive even seating, the Calmec ball guided valves are designed with these features in mind.

A catalog giving details of design and construction and prices on this new valve is available upon request.

New Fire Extinguisher

SOUTHERN LABORATORY

Southern Laboratory, Richmond, Virginia, is introducing to the oil industry Lightning fire extinguisher, a patented chemical product for rapidly extinguishing fires. The product is a combination of six chemicals, and is put up in quart containers in dry chemical form. While the quart containers hold two pounds of the extinguisher, the product disseminates and floats in the air when thrown from the hand or the container.

The extinguisher is thrown at the base of the fire, spreading in the air when liberated. When coming in contact with

TAG Industrial Thermometers

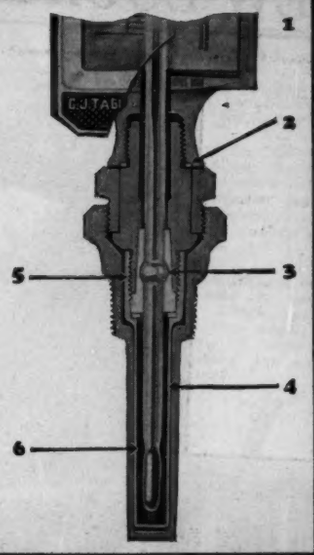
With NEW Snap Case-Front and other improvements

SNAP . . . the case-front of the NEW TAG Industrial Thermometer is off. No screws to bother with when removing the glass to clean it. Snap . . . it's on again . . . securely. The front can't fall as it is held firmly by a tongue and groove at the top.

SUPERIOR STRUCTURAL FEATURES

1. TAG-Hespe glass—easy to read.
2. Asbestos packing, uniformly compressed around enlargement on glass stem prevents movement of tube with reference to scale.
3. Left handed thread on bulb chamber prevents loosening if case is turned in removing thermometer.
4. Thin Monel bulb chamber allows quick conductivity, yet is rugged and non-corrosive.
5. Connecting piece locked to case by specially designed split spring washer.
6. Mercury filling in bulb chamber completely surrounding bulb insures split-second transmission of heat.

Bulletin No. 1033-52—just off the press—describes and illustrates in detail the features of this NEW TAG Industrial Thermometer. Send for it!



C. J. TAGLIABUE MFG. CO.

PARK AND NOSTRAND AVES., BROOKLYN, N. Y.

Instruments for Indicating, Recording and Controlling

BRANCH OFFICES AND *FACTORIES

BIRMINGHAM, ALA. BOSTON, MASS. CHICAGO, ILL. *CLEVELAND, OHIO PITTSBURG, PA.
PORTLAND, ORE. *SAN FRANCISCO, CALIF. *SHREVEPORT, LA.
ST. LOUIS, MO TORONTO, ONT., CAN.

TAG C. J. TAGLIABUE Mfg. Co. BROOKLYN

HAVING GASKET PROBLEMS?

LET US SOLVE THEM FOR YOU!

We make metal gaskets of any size or shape, plain or corrugated, with or without asbestos, also plain solid washers of copper, aluminum, monel metal or any material desired. Our Gasket Guide shows a very complete line of gaskets suitable for refinery work.

Copy sent upon request.

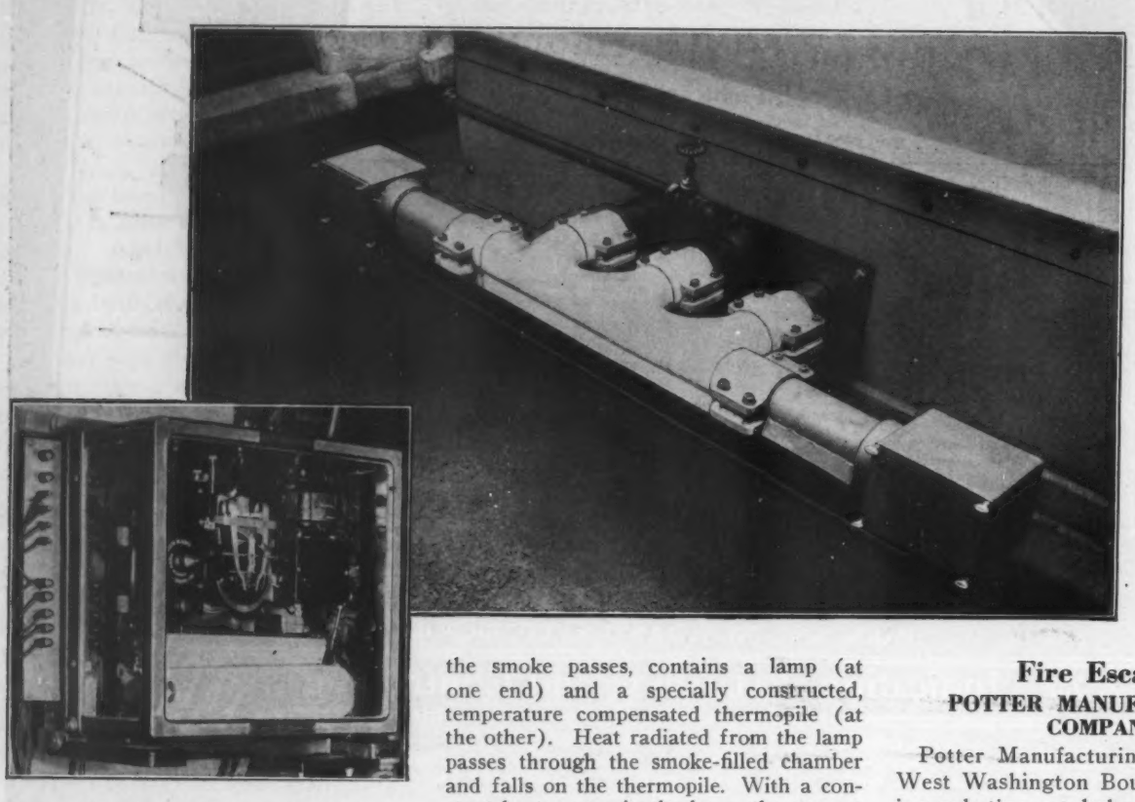
GOETZE

Gasket&Packing Co., Inc.

P. O. Box 175
NEW BRUNSWICK, N. J.

A Few Types of Goetze Gaskets

NEW EQUIPMENT FOR THE MODERN PLANT



the flame the chemical combination becomes carbon dioxide, smothering or snuffing out the blaze.

While the product is being introduced primarily for the extinction of small fires before the blaze has had time to spread over a wide area, it has been found applicable to gas well fires and small oil tanks. Eylers Oil & Gas Company's Chaffraix 3 well in Red River Parish, Louisiana, was recently snuffed out with the Lightning fire extinguisher after it was ignited by a spark while flowing several feet of gas daily.

J. A. Burton, who is introducing the product to the oil industry in the Southwest, announces the appointment of Norvell-Wilder Supply Company and T. T. Word Supply Company as distributors in Texas and Louisiana. Complete details on the product or a demonstration of how it is used to snuff out oil or gas fires may be had by writing J. A. Burton, Box 4177, Houston.

L. & N. Smoke Recorder

LEEDS & NORTHRUP COMPANY

Leeds & Northrup Company, 4901 Stenton Avenue, Philadelphia, announces the L. & N. Smoke Recorder, which the manufacturers describe as consisting of a measuring chamber at the stack or breeching, a recorder at any convenient location and an indicator at the boiler.

The measuring chamber, through which the smoke passes, contains a lamp (at one end) and a specially constructed, temperature compensated thermopile (at the other). Heat radiated from the lamp passes through the smoke-filled chamber and falls on the thermopile. With a constant heat-source in the lamp, the amount of heat falling on the thermopile is inversely proportional to the density of the smoke. The heat from the lamp which reaches the thermopile causes it to generate a voltage. The measurement of this voltage is the measure of the smoke density.

The recorder is a standard L & N Potentiometer Recorder. It measures the voltage of the thermopile and reads directly in per cent smoke density or Ringlemann chart numbers.

The boiler-room indicator is a bank of five lamps. The color of the lamp burning, instantly tells the fireman the smoke condition in the stack.

The boiler room indicator instantly tells the fireman the smoke condition, and the recorder furnishes a continuous record 24 hours a day. A specially constructed thermopile is used as the directing element. The density measurement is said to not be affected by line voltage fluctuations.

The company's home office, mentioned above, will furnish more complete details upon request.

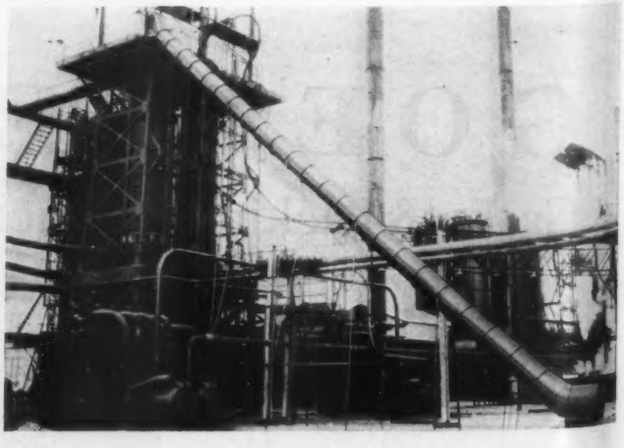
Fire Escapes

POTTER MANUFACTURING COMPANY

Potter Manufacturing Company, 111 West Washington Boulevard, Chicago, is marketing a tubular fire escape such as the one in the accompanying illustration, showing the one installed on the Dubbs plant at the Houston refinery of Shell Petroleum Corporation.

These tubular escapes are 30 inches ni diameter, and installed at approximately a 35-degree angle, and are so designed as to assist the employee in escape in the event of fire. As can be

The tubular escapes have been installed primarily as an additional protection to employees whose duties require them to work on top of these units, and in addition considerable time can be saved by the use of the escapes for descending from towers.



Potter Fire Escape

FOR SOUTHWESTERN REFINERS

TEXAS FIRE BRICK

Elgin Butler Brick Co., Austin, Texas

Athens Brick & Tile Co., Athens, Texas

Acme Brick Company, Ft. Worth, Texas

Texas Clay Products Co., Malakoff, Texas

A Quality Product

QUICKLY AVAILABLE AT LOW COST

Texas Fire Brick meet refractory requirements ordinarily expected of higher priced brick. Shipped to Southwestern points at an appreciable saving in freight. Time-saving short hauls from large stocks.

Write for prices.

FIRE BRICK DIVISION

of the SOUTHWEST CLAY PRODUCTS INSTITUTE

ADDRESS ANY MEMBER LISTED

THE HOIST WITH A FIVE-YEAR GUARANTEE

UNION *Spur Gear*

Reversible Load Sprocket, obtainable only in UNION HOISTS, insures twice the durability of the usual hoist construction. Large roller bearings. Alloy steel cut gears (heat treated). Steel plate suspension. Forged hooks and swivels. Alloy steel shaft and axle. Electric welded carbon tested chain. Outside oiling, dust proof, with self-cleaning and self-closing oil cups. Every Union hoist is tested to 50% overload.

MADE BY THE MAKERS OF

UNION CHUCKS

Catalog and Prices on Request

Ask Your Dealer or Write Us

Union Manufacturing Co.

New Britain, Connecticut

Branch Offices Carrying Stocks: NEW YORK, 26 Cortlandt St.; CINCINNATI, 332 Sycamore St.; CHICAGO, 27 S. Jefferson St.; SAN FRANCISCO, 661 Folsom St.; HOUSTON, I. Van Tassel, 1120 Union National Bank Building.

HOISTS

These Exclusive Advantages Explain the World-wide Preference for No. 3 Beaver

No. 3 Beaver Ratchet
⅛" to 1" Inclusive
Buy any Range of Die Heads

Note the Oil Holes in the Die Heads

(Just one of *many* improvements made in the BEAVER Line. Ask for Catalog.)

No. 3 Beaver is an "all purpose" tool. Whether the pipe is in a corner—or ditch—close to walls or ceilings, or out in the open at the bench, No. 3 Ratchet threads it quickly and easily.

Bolt Die Holders, for use with No. 3 Ratchet take the standard makes of 2-inch round adjustable Bolt Dies regularly sold by dealers. A separate Holder is required for each size—¼ to 1 inch.

1

The sturdy die heads are easily and quickly slipped in or out of the drive ring when changing from one size to another.

2

Cross-section of die head with dies removed. Note oil holes between the dies that permit placing oil directly on the face of the dies—assuring better threads and long life to threading dies. These oil holes also allow chips to fall out and away from the dies—further protection to dies and threads.

3

Die segments are square in shape—not weakened by a "shoulder" or offset. No "tip" to break off. Dies are electrically heat-treated and hardened by our own special process which provides each die with the maximum of perfect threading service.

4

Ratchet gear teeth are on a separate fully enclosed ring. Dirt and chips which act as an abrasive cannot enter this ring to wear down the gear teeth. An exclusive Beaver feature!

5

Note the broad, deep and square gear teeth — and the sturdy "full gripping" ratchet pawl that assures smooth ratchet operation free from back lash that results when exposed ratchet teeth wear down prematurely.

6

The construction of the drive ring is such that the die heads are held firmly in position and will not drop out when threading in inverted positions — also an advantage when starting a thread.

ALL LEADING SUPPLY HOUSES CARRY IT IN STOCK

Write us for catalog covering the complete line of new and improved Beaver Pipe Tools.

The Borden Co., 520 Dana Ave., Warren, O.

*SOLVAY
TRADE MARK REG. U. S. PAT. OFF.
PRODUCTS

58% Soda Ash
Caustic Soda

Solid—Flake—Ground—Liquid

Leading refiners depend on these products for the quality and uniformity which industry inevitably associates with the name Solvay. First in pioneering the development of American sources of alkali, The Solvay Process Company is recognized as the outstanding leader of its field—first in size and first in facilities for rendering efficient service. Strategically located distributing points ensure prompt delivery of Solvay products with minimum transportation charges.

Write today for prices and full information.

Solvay Sales Corporation
Alkalies and Chemical Products Manufactured by
The Solvay Process Company
New York
61 Broadway

*"SOLVAY" Trade Mark Reg. U. S. Pat. Off.

Carbondale Refrigeration
CARMACO for Refiners

Send for a Copy of our Wax Plant Bulletin

Design of Complete Wax Plants—Absorption and Compression Refrigerating Machines—Wax Distillate Chilling Machines—High Pressure Filter Presses—Paraffine Wax Sweaters—Heat Exchangers and other Refinery Equipment.

CARBONDALE MACHINE COMPANY, CARBONDALE, PA.
SALES OFFICES
New York Los Angeles Buffalo Chicago Pittsburgh Tulsa Kansas City Philadelphia Boston

Items About Manufacturers

Alco Products, Incorporated, division of the American Locomotive Company, has announced the opening of branch offices in the Esperson building, Houston, and in the Philtower building, Tulsa. R. H. Brinton will represent the company at Houston, and T. B. Leech, at Tulsa, as sales engineers for refinery installations and heat exchange equipment.

American Metal Products Company, South 39th and Burnham Streets, Milwaukee, Wisconsin, has appointed General Supply Company, 317 Merchants & Manufacturers Building, Houston, exclusive distributors in the Houston territory, handling Ampco non-sparking tools for eliminating fire hazards and Ampco metal used in the manufacture of tools and equipment.

Catalog No. 3, covering the line of non-sparking tools, and Catalog No. 18, covering Ampco metal, are available by writing the Houston office or to the home office at Milwaukee.

Bailey Meter Company, Cleveland, Ohio, announces a new bulletin, entitled "Power Type Pressure Devices," describing a pressure gauge which embodies dead weight tester accuracy and permanence of calibration together with power for the operation of remote type indicators, recorders and control devices. This is bulletin No. 70, and describes Bailey power type pressure devices. A copy will be furnished upon request direct to the Cleveland office,, 1050 Ivanhoe Road.

Cooper-Bessemer Corporation, Mt. Vernon, Ohio, has issued a folder outlining a plan to enable users of Cooper-Bessemer engines to put 1931 efficiency into older models. A replacement steel cylinder head, power cylinder and gas economizer are included in the plan, which may be applied in whole or in part to any Type-8, Type 10, or Type EC engine now equipped with the 16-inch cylinder. The company will forward a copy of this folder to interested persons upon request.

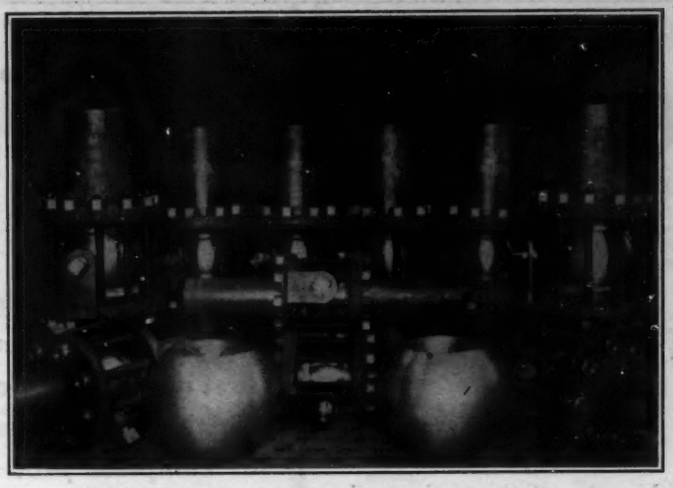
Denver Fire Clay Company, Colorado National Bank building, Denver, has appointed The Peden Company, Houston distributors for the full line of "DFC" refractories, including Hifire, Champa, Cupola and Ibex fire clay brick; PX-33, a moldable furnace lining; Latite, an air-setting high-temperature bonding mortar; Hifire bond, a dry high temperature bonding mortar; Calibex, Grogite and other refractory specialties. Adequate stocks of these materials will be maintained by the new distributor in Houston. A similar appointment has been made to E. L. Wilson Hardware Company of Beaumont, Texas, a Peden Company owned organization.

Ires Prosser is Texas and Louisiana representative for Denver Fire Clay Company.

Duriron Company announces the election of officers at a meeting held in New York City recently, as follows: William E. Hall, president; Dudley H. Miller and John R. Pittman, vice-presidents; Robert C. Schenck, secretary; and E. B. Thacker, treasurer.

Dudley H. Miller was appointed general manager. William E. Hall, as president, succeeds P. D. Schenck, the late president and founder of the company.

Do you require machined stainless steel Parts ?



Ground joint stainless steel shut-off valves 3", 4", 6" and 8" size.

We are equipped to produce your requirements in stainless steel fabricated or machined units, whether it is small or large, rough or machined, polished or ground.

Specializing in alloy steel fabricating, we are producing special alloy units to our customers' most rigid specifications for all industries where resistance to corrosion or high temperature oxidation is an important factor.

Let us work with your engineers to produce the best design alloy units for economy in your installations.

ALLOY WELDING & MANUFACTURING CO.

Pittsburgh, Pa.

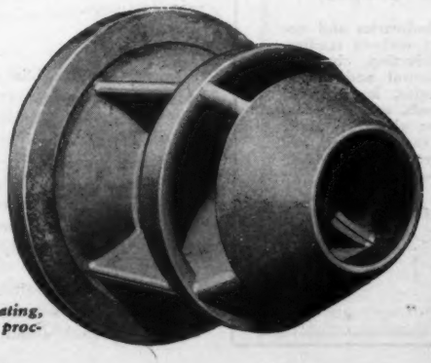
25 CHURCH STREET, NEW YORK CITY — 950 DIERKS BLDG., KANSAS CITY, MO. — 733 MAYO BLDG., TULSA, OKLAHOMA

. . . SAVED!

Money Spent for Chemicals Reduced Five Percent by Duriron Mixing Nozzles

Important savings are effected through the use of Duriron mixing nozzles. Oil companies confirm our findings that there is more than a 5% saving in acid requirements where Duriron nozzles are used. Also there are marked savings in power and in the cost of installing gasoline treating systems. Many of the major oil companies have replaced baffles and spools with Duriron equipment for these reasons only.

Our engineers will gladly furnish data to those interested.



Duriron mixing nozzles are highly resistant to corrosion, abrasion and high velocities. Their turbulence brings all of the acid in contact with all of the gasoline. Designed for bolting between pipe flanges of a pipe column. Used in treating, washing and blending processes.

THE DURIRON COMPANY, INC.

412 N. Findlay St. Dayton, Ohio

See our exhibit, Chemical Show, May 4-9, Booth 20.

DURIRON

Latite *adds life* to furnace walls

Note how Latite coating and joint withstood temperatures which vitrified brick with melting point of 3200° F. No signs of fusion or checking of the Latite!

Write for Bulletin 144.

▼

The softening point of Latite is higher than that of first quality fire clay brick. That's why you are sure of *complete protection to brickwork* when you have used Latite . . . either for laying up firebrick, patching, or coating.

Latite meets *every* high-temperature bonding mortar requirement.

▲

THE DENVER FIRE CLAY COMPANY

DENVER DFC COLO. U.S.A.

BRANCHES AT SALT LAKE CITY, EL PASO, AND NEW YORK

DFC Distributors:

El Paso, Texas	Neff-Stiles Company
Beaumont, Texas	E. L. Wilson Hardware Co.
Houston, Texas	Peden Company
Wichita Falls, Texas	Greene Brothers
Los Angeles, Calif.	H. F. Bakemeyer
New Orleans, La.	J. J. Clarke Co., Inc.
Ogden, Utah	Ogden Press Brick & Tile Co.
Phoenix, Arizona	V. L. Clark Building Material Co.
Portland, Oregon	Kline Specialty Co.
Provo, Utah	Provo Brick & Tile Co.
Reno, Nevada	Flanigan Warehouse Co.
San Francisco, Calif.	W. E. Mushet Co.
Santa Fe, N. M.	Santa Fe Builders Supply Co.
Tucson, Ariz.	Mulcahy Lumber Co.

ASPHALTS AND ALLIED SUBSTANCES

By HERBERT ABRAHAM, B.S., *President, The Ruberoid Company*

The tremendous scope of this book, the great number of industries and occupations to which it applies, cannot be adequately realized without reading its table of contents. There are not only methods of production, chemical and physical properties, of asphalts, tars, and pitches, natural and manufactured, but their actual use in making paints and shingles, impregnated paper and floor-covering, in building roads and covering roofs, and countless other products and operations. In just this detailed way are given the many chemical and physical tests made on all these bituminous raw materials and the products manufactured from them, and representative properties are tabulated for asphalts, pitches and tars from all parts of the world.

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Items About Manufacturers

Edward Valve & Manufacturing Company, East Chicago, Indiana, shows excellent views of patterns and core boxes for body and bonnet of Edward angle non-return valve with special elbow inlet, the company's eight-inch angle non-return valves, special 16-inch Edward valve at Grand Avenue station of Kansas City Power & Light Company, Kansas City, Missouri, and of Edward 60-degree globe valves on gas header lines in the March, 1931 issue of "Valve Values," a pocket size pamphlet published monthly by this company. The motor operated globe valve of this company is completely described as is other equipment manufactured by the company. A copy of "Valve Values" is available upon request by writing the above office.

The Elliott Company, Pittsburgh, Pennsylvania, with works and sales headquarters at Jeannette and Ridgway, Pennsylvania, has produced an attractive bulletin, 24 pages and cover, entitled "Power Plant Equipment." This bulletin covers the entire Elliott line of power equipment, devoting one page to a product, and including the tube cleaners manufactured by its associates, Liberty Manufacturing Company and Lagonda Manufacturing Company. Products briefly shown and described in the bulletin include turbine and engine-generator units, motors and motor-generators, centrifugal blowers, condensers, ejectors, deaerators, feed-water heaters, desuperheaters, strainers and power accessories.

Flexitallic Gasket Company, Eighth and Bailey Streets, Camden, New Jersey, announces the appointment early in 1931 of E. H. Bolton's organization, 549 West Randolph Street, Chicago, as representatives of its products in the Chicago territory, where the Bolton organization is well known throughout the industrial district for its counsel in connection with the solution of mechanical difficulties arising in industrial plants.

General Electric Company, Schenectady, has recently released its thirty-ninth annual report, covering 1930. It is covered in a 28-page booklet, which may be secured upon request.

Hills-McCanna Company, 2349 Nelson Street, Chicago, has issued a four-page folder showing this company's line of lubricators in pictures and brief description, featuring the Kam-Klutch drive or ratchet drive available in these lubricators. Latest information on the new and improved designs of lubricators of Hills-McCanna Company may be had by writing the manufacturers.

Jones & Laughlin Steel Corporation has closed a deal whereby it takes over the plant of Lukens Steel Company at New Orleans, giving the former a direct outlet to the Gulf and sea-going vessels. In addition this plant will give Jones & Laughlin a large, modern steel fabricating, warehousing and distributing base near the mouth of the Mississippi river which can be served directly by river transportation from Pittsburgh.

The Lukens warehouse and fabricating shop is on a 17-acre site on the turning basin of the industrial canal, about one mile from the Mis-

Items About Manufacturers

sissippi river, and about six miles from the center of the city.

With delivery this spring of two modern towboats, Jones & Laughlin Steel Corporation will have a river fleet of 12 towboats and 250 modern steel barges with a carrying capacity of 200,000 tons.

GEORGE G. LANDIS

Lincoln Electric Company, Cleveland, Ohio, announces the advancement of George G. Landis to chief engineer. He is a graduate in electrical engineering of Ohio State University. His record since graduation includes a connection with General Electric Company where he was engaged in the design of small motors, and later with Westinghouse Electric & Manufacturing Company as sales engineer for central station equipment. He has been with Lincoln Electric Company for eight years, being first placed in charge of experimental activities, and later in charge of electrical design of both motors and welders.

A. Y. McDonald Manufacturing Company, Dubuque, Iowa, announces publication of a 12-page booklet entitled "The Home of the Swing Joint," which describes many new items not listed in its Oil Equipment Catalog. Leading products shown in this booklet include the new McDonald line strainer and the new foot valve. Three pages are devoted to showing illustrations and numbers on the parts of the company's various items. Refiners and jobbers not having a copy of this pamphlet will be mailed one upon request.

Merco Nordstrom Valve Company announces removal of its Los Angeles office, formerly at 556 South San Pedro Street, to new and larger quarters at 1709 West Eighth Street. The move, according to H. Boezinger, manager for Southern California, was necessitated by a need for a more central location and additional space.

Morey & Jones, Ltd., manufacturing engineers, formerly Morey, Jones & Lovell, Inc., 922 South Hemlock Street, Los Angeles, announces the publication of Bulletin Number 205, covering Type DK MJL Regulator for combustion control; Bulletin Number 209, MJL orifices and orifice flanges; Bulletin Number 208 (Series E), covering MJL flow indicators; Number 207, covering MJL high pressure manometer; and Number 206, covering MJL duplex control valve unit of the company. Any of these bulletins will be mailed to interested parties upon request.

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Items About Manufacturers

Metalastic, Inc., 546 Thirty-Ninth Street, Union City, New Jersey, has appointed General Supply Company, 317 Merchants & Manufacturers building, Houston, as territorial distributor for its line of packing.

The new Metalastic packing in coils for use in oil field and refinery equipment is described in an eight-page pamphlet recently issued by the company, a copy of which is available upon request.

Neilan Company, Ltd., 641 Santa Fe Avenue, Los Angeles, describes the new Neilan ball bearing multiple spring reducing regulator and excess pressure relief valve in bulletins No. 206-B and No. 207-B, each a four-page folder describing and illustrating the two above products, respectively. Engineers will find these descriptions interesting from the improved type of "Seatringuide" valve which is machined from rolled bar stock Monel metal, the application of frictionless stainless steel ball bearings as well as multiple springs. Both bulletins are punched for filing in loose-leaf folder, and will be mailed upon request.

Northern Equipment Company, Erie, Pennsylvania, announces the appointment of Bell & Eiss, Inc., 459 Northwest National Life building, Minneapolis, Minnesota, as representatives for Copes feed water regulators, differential valves, pump governors and allied equipment.

Northern Equipment Company further announces the appointment of Joseph W. Eshelman, 1220 Webb-Crawford building, Birmingham, Alabama, and The Economy Equipment Company, 301 Buder building, St. Louis, as other territorial representatives of the above mentioned line.

Neilan Company, Ltd., 641 Santa Fe Avenue, Los Angeles, manufacturers of automatic control and regulating equipment, announces the addition to its staff of O. H. Seal, to be located in the New York office at 30 Church Street, New York City.

Neilan Company, Ltd., 641 Santa Fe Avenue, Los Angeles, announces the appointment of William T. Mayer as manager of the San Francisco office, located in the Crocker building. Mayer has been engaged in the past in public utility engineering and butane plant design.

Oliver United Filters, Inc., Hazleton, Pennsylvania, has acquired the rights to manufacture and sell the stream line filter in North America. This filter is designed to clarify the problem of

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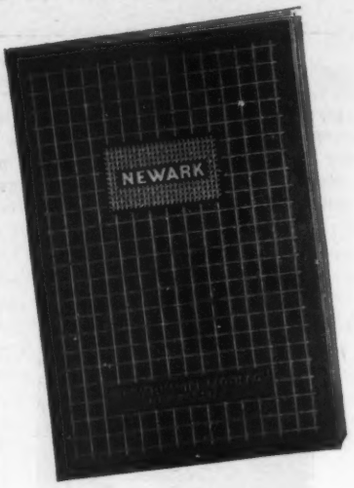

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Newark Wire Cloth Catalog No. 26, shown above, tells how to select, order, and test Wire Cloth for the refinery.

Every refiner who uses or is a prospective user of wire cloth should have the helpful and informative data assembled in this catalog. All Newark Wire Cloth products are fully described. Many tables of useful data are given.

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Items About Manufacturers

thin suspensions such as brine, water or oil, although it is not limited to this type of work alone.

Bulletin No. 302 has recently been issued by the company describing the various filtering accessories available through Oliver United Filters, Inc. This is a loose-leaf booklet of 16 pages with the complete line of filters of the company illustrated and described. A copy of this bulletin is also available upon request.

Schutte & Koerting Company announces Section 9-P of its descriptive bulletin, mailed out for insertion in the SK valve catalog, Volume 6, to replace any previous literature covering the company's line of steam purifiers. The question of removal of moisture and impurities from live steam, an important problem, is described in this bulletin, which Shutte & Koerting Company will forward upon request to its headquarters in Philadelphia.

The Sarco Company, Inc., 183 Madison Avenue, New York City, has mailed out an attractive eight-page booklet covering Sarco thermostatic steam traps for individual trapping systems. In thir booklet, which is illustrated, the purpose of steam traps, why the thermostatic feature is a part of Sarco traps, and the advantages of individual trapping. The technical points of the Sarco features are brought out in drawings to illustrate the author's explanation. A detailed, cut-away drawing is carried of Sarco Company's steam trap No. 9, the balanced pressure type, self-adjusting for all pressures from zero to 100 pounds. List prices of Sarco traps, also capacities, are published in tabular form in this booklet, a copy of which is available for the asking.

Worthington Pump & Machinery Corporation, Harrison, New Jersey, announces the publication of a four-page specification sheet, W-112-S10, covering its horizontal duplex piston pattern oil pumps, Type S-P, a two-page sheet, D-423-ES, covering power pumps, vertical triplex single-acting, a four-page sheet, W-112-S11, covering horizontal duplex piston pattern heavy pressure hot oil pumps, Type S-P, and a four-page sheet, W-200-S10, covering the company's surface condenser, patented folder tube layer type. Any of this literature will be forwarded to interested oil companies upon request.

White Star Refining Company has contracted for a debutanizer and stabilizer plant to be furnished by Foster Wheeler Corporation. This plant will be installed at Detroit, Michigan, in connection with an existing gasoline absorption plant. The new unit will also process pressure distillate in addition to natural gasoline. The peak capacity of the plant will be 165,000 gallons per day of pressure distillate and 50,000 gallons per day of raw gasoline from the present absorption plant.

Frick Company, Inc., Waynesboro, Pennsylvania, has recently issued a new ice and frost bulletin on the subject of "Equipment for Making Carbonic Ice." This is Bulletin No. 124-A, which tells the story in pictures and brief explanation of this line of equipment. The design and operation of the machines are clearly outlined, with photographs used for illustrating the subject material. Operators interested in having a copy of the bulletin should write Frick Company's Waynesboro office.

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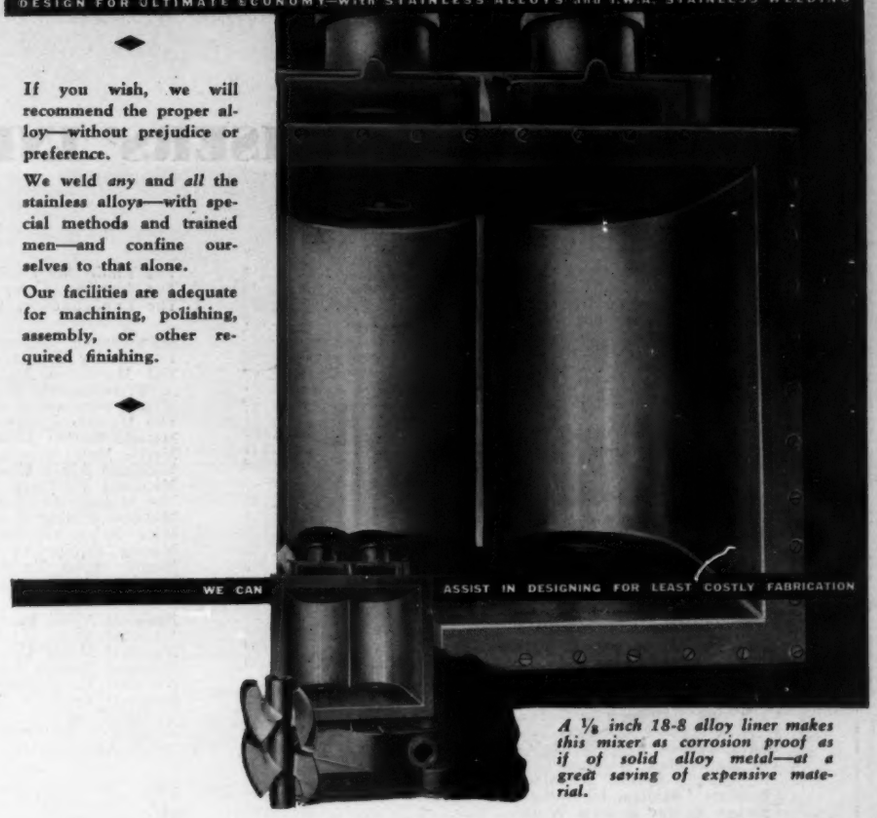

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